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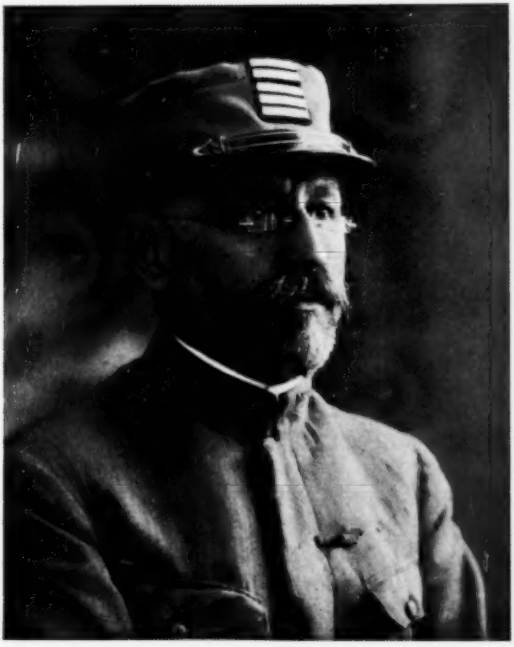

JEAN BERGONIÉ

In memoriam

La nouvelle douloureuse d'une perte irréparable pour la radiologie se répand de nouveau dans le monde. Le 2 janvier, JEAN BERGONIÉ, le Maître de la radiologie et de l'électrothérapie, a été rappelé à jamais du poste élevé qu'il occupait au service de la

science et de l'humanité et de telle sorte que l'honneur de sa patrie en recevait un nouvel éclat.

Ayant succombé, après de longues souffrances héroïquement supportées, à un cancer multiple développé à la base d'une radiodermite, l'auréole du martyr jette sa lueur mélancolique sur sa mort. Mais d'une lumière plus radieuse encore que celle de l'auréole du martyr on verra à tout jamais briller la flamme qu'a allumée JEAN BERGONIÉ par son travail génial et intense et par l'influence stimulante de sa personnalité si entraînante et pleine de vitalité.

BERGONIÉ était par ses études extraordinairement bien armé pour atteindre au succès dans la branche de la médecine à laquelle il a consacré sa vie.

JEAN BERGONIÉ était né le 7 octobre 1857 à Casseneuil (Lot-et-Garonne). Licencié ès sciences physiques et ès sciences naturelles et docteur en médecine, il se spécialisa dans l'étude de la physique médicale. Nommé agrégé des facultés de médecine de France, 1883, il a été depuis 1891 professeur de physique médicale à la Faculté de Médecine de Bordeaux et chef du service électrothérapique des hôpitaux.

En qualité d'ouvrier sur le domaine de la radiologie, BERGONIÉ s'est fait connaître surtout en démontrant avec TRIBONDEAU le rapport remarquable qui existe entre la radiosensibilité des cellules et l'activité reproductive d'un édifice cellulaire.

En physique médicale, BERGONIÉ a exécuté un grand travail fondamental, travail surtout renommé peut-être par l'électrothérapie passive qu'il sut organiser. Il était sans doute le premier électrothérapeutiste du monde. Pendant la guerre, malgré son âge et ses lésions, BERGONIÉ s'est mis entièrement à la disposition de la patrie comme chef du centre radiologique de la 18e région. Par l'invention de son « électro-vibreur » pour la localisation des projectiles, le génie de BERGONIÉ a offert à la guérison des victimes de la guerre un moyen de grande valeur.

Comme principe de cet appareil BERGONIÉ a employé pour la localisation des projectiles les vibrations données par les électro-aimants alternatifs aux fragments métalliques dans le voisinage des pôles. Placé au-devant d'une région du corps renfermant un fragment métallique, l'électro-vibreur cause des vibrations du fragment à l'aide desquelles le doigt le peut localiser exactement.

L'œuvre scientifique de BERGONIÉ est d'une valeur dominante. Un mérite encore plus grand s'attache peut-être à son œuvre de précurseur et d'organisateur de l'enseignement de la physique médicale et de fondateur, en 1893, et de rédacteur, depuis lors, de la revue « *Les Archives d'Electricité Médicale* ». Dans cette revue, a

trouvé place la discussion scientifique des expériences de la physique biologique, surtout sur le domain de l'électricité médicale. Elle réunit autour d'elle les meilleurs auteurs de la France. Dès les découvertes de ROENTGEN, de BECQUEREL et des CURIE cette revue s'est trouvée immédiatement prête à lancer les rayons nouveaux au service de la médecine.

A partir de cette époque, la création de JEAN BERGONIÉ, Les Archives de l'Electricité Médicale, a été, durant une existence d'homme, pour tous ceux qui se sont consacrés à l'étude de l'emploi médical des rayons de Roentgen et des rayons des Curie une source vivante de science et d'inspiration.

En 1908, j'avais le plaisir de passer quelques semaines à Bordeaux comme disciple de BERGONIÉ. Je garde précieusement et avec une reconnaissance profonde le souvenir de sa personnalité entraînante, pleine d'énergie. Sa vitalité ainsi que son enthousiasme furent communiqués à l'entourage, inspirant aux clients une espérance renaissante et un désir nouveau de vivre et allumant chez les disciples l'amour de la Science et du Maître. En me souvenant de ces jours heureux passés chez BERGONIÉ à Bordeaux, je ne puis oublier non plus le foyer aimable et hospitalier qui s'est ouvert à moi. J'eus l'impression que BERGONIÉ pour son travail avait dans sa femme un appui inappréciable. Pour la rédaction de sa revue les vastes connaissances philologiques de Madame BERGONIÉ étaient d'une grande valeur.

JEAN BERGONIÉ a fait don à la Science et à l'Humanité souffrante de sa vie puissante. Dans ses dispositions testamentaires il demande que son corps soit livré à la faculté de médecine en vue de prélèvement de certains organes qu'il a indiqués pour l'étude de l'effet des rayons sur l'organisme. Il a légué sa bibliothèque à la faculté de médecine de Bordeaux, l'appareillage de sa clinique et une somme de cent mille francs au premier centre anticancéreux de la France qu'il a organisé à l'annexe St. Raphaël, contigu à Saint-André, à Bordeaux.

La radiologie médicale s'est rapidement élevée à une grande discipline pratique. Ses progrès la conduisant à l'état de science complètement développée ne pourront se faire que lentement et elle se trouve encore au premier début. Il y a aujourd'hui un très petit nombre d'hommes de la mesure de BERGONIÉ se consacrant à cette jeune branche de la médecine. Pendant longtemps le chef, en France, sur le domaine de la physique médicale, et l'une des colonnes d'appui les plus importantes de la radiologie et de l'électricité médicale du monde entier, BERGONIÉ a déblayé le terrain et indiqué le

chemin à suivre pour le développement de la physique médicale et de son enseignement.

De grands hommages furent rendus à BERGONIÉ de la part de son pays et de celle de tout le monde scientifique. Il était membre honoraire de la Société Scandinave de Radiologie Médicale.

En témoignage de leur reconnaissance profonde pour ce que la Science française, par l'œuvre de JEAN BERGONIÉ, a donné à notre discipline, les radiologues de la Scandinavie et de la Hollande présentent leurs hommages sincères et respectueux devant le cercueil du Maître.

Gösta Forssell.

FROM THE ROENTGEN CLINIC OF THE RIGSHOSPITAL, COPENHAGEN
CHIEF: H. J. PANNER, M. D.

INVESTIGATION INTO THE BIOLOGICAL EFFECT OF FILTERED AND UNFILTERED X RAYS, AS MEASURED ON PEAS [1, 2]

by

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Copenhagen Aarhus

The radiotherapeutist constantly feels the lack of some handy and reliable measuring apparatus for determining the quantity of X-radiation.

Our idea, in entering on the present investigations, was to try to find some biological standard by which it would be possible to control the various apparatus of this kind at present used in radiotherapeutic practice.

The problem has engaged other workers before us, notably JÜNGLING. But the chief difficulty, for most of them, has been to find some medium which, at the same time as it was not too difficult to keep growing, would be both easily influenced by the X rays and easy to measure accurately.

As our investigations proceeded, they incidentally opened a number of other questions unexpected by us, and our work is by no means terminated. Still, even among the results obtained so far, we believe there are some for which we may justly claim a wider attention.

The chief interest in connection with the investigations into the biological effect of the X rays has always centered around two problems: whether there is any dosage in which that effect will be a growth-promoting one, and whether filtered and unfiltered rays, administered in supposedly identical doses, produce the same, or a different, biological reaction.

[1] A paper read at the meeting of the DANSK RADIOLOGISK SELSKAB, April 9th, 1924.

[2] The *Rask-Ørsted Foundation* has kindly payed the authors' expenses in publishing this paper.

All the experiments, both animal and botanical, show that even moderately strong X-ray doses produce inhibition, and that further increase of the dosage kills.

By experiments with eggs of the thread-worm of the horse (Strongylus equinus), PERTHES and HOLTHUSEN have shown that it is chiefly the chromatin contained in the nucleus of the cell that becomes affected by the X-radiation, and this is the conclusion come to, also, by SCHAPER, HERTVIG and others, as a result of their observations on frog's eggs.

But the protoplasma, too, is subject to changes under the influence of the X rays. BONIN and BLEIDORN, for instance, have found that the non-nuclear erythrocytes in the blood of man lose their power to resist hemolytic agents.

A stimulatory effect of small X-ray doses seems to have been observed by LAZARUS BARLOW, and by BONNEY and BECTON, in eggs of the Ascarides, of which they say that the division became accelerated "under particularly favorable circumstances". In the silkworm, HASTINGS, BECTON and WEDD have noticed a shortening of the cocoon stage, an increased average weight of the cocoon itself, and a more rapid development, altogether, of the specimens subjected to weak doses of X-radiation.

A number of investigations have been made concerning the stimulatory effect of the rays, on frog's eggs. HOFFMANN, for instance, has observed an accelerated development of the latter under the influence of a mild irradiation.

In Protozoa (Infusorium paramæcium caudatum), MARKOVITS found that small mesothorium doses caused a more rapid division of the cells, and that the stimulating effect continued even under increased dosage (in the interval from 5 to 90 minutes). He would conclude, from this fact, that the unicellular organisms are but slightly sensitive to X-radiation.

On the other hand, numerous investigators have looked in vain for any stimulatory effect of the rays. It would seem that the conditions surrounding the medium of experimentation need be particularly favorable if success is to be obtained. Thus, the stimulatory effect on frog's eggs, for instance, manifested itself only when the temperature was not too low; and altogeter it is probable that this effect can only be demonstrated when the medium is in a period of vigorous growth. —

Upon the whole, it would seem that botanical media are better for the purpose of experimentation. They are rather easily affected by the rays, and they offer a far greater possibility of obtaining a biological standard for dosage.

Numerous investigations have proved that the sprouting seed is far more easily reacted upon than the full-grown plant, and that the dried-up seed is almost completely irresponsive to the action of the X rays. ERWIN SCHWARTZ, for instance, on comparing with the control specimens a number of horsebeans (Vicia Faba equina) which he had irradiated with as much as 40 Sabouraud-Noiré, found that their growth had hardly been checked at all. The sensibility of the seed to X-radiation is apparently proportional to the intensity of the metabolism. Furthermore, it has been found that the nucleus of the cell displays a higher degree of sensibility than the zytoplasma.

A stimulatory effect has been observed by several investigators. In 1906, EVLERS subjected beans, radish-, watercress-, and pumpkin seeds to a moderate irradiation and found that the process accelerated their development. A like result, from irradiation of sugar-peas that had been soaked in water for six hours beforehand, was recorded by H. E. SCHMIDT, who states that the stimulating dose lies around $^1/_{20}$—$^1/_{10}$—$^1/_4$ H. E. D.

ERWIN SCHWARTZ states the stimulating dose for beans (Vicia Faba) to lie around $^1/_{200}$ H. E. D.

Nearly all the experiments have been carried out by the device of planting the seeds immediately after irradiation and then noting the earlier appearance and stronger growth in the early stages, of these plants, as compared with the appearance and growth of the non-irradiated specimens planted for control.

A few investigators, however, have had their attention fixed on the growth of the root, as well. JÜNGLING is one of these; but after a long series of experiments with Vicia Faba he declared himself unable to detect any stimulatory effect on the radicle.

If the development of the irradiated specimens is watched for a sufficient length of time it will be seen that the stimulatory effect lasts for a shorter or longer while. In the end, however, the full-grown plant will not have outgrown the control specimen; a "giant growth" such as was formerly fabled about, is entirely out of the question. —

The stimulating dose, as recorded by the investigators, seems to be different for the different species of plants. Of the actual strength of dosage, in the various cases, it is very difficult to form an exact idea, owing to the insufficiency of the indications furnished; but nearly all the investigations show the stimulating dose to have been a very slight one, which is to say that, for the plants, it is found in the neighbourhood of from $^1/_{50}$ to $^1/_{10}$ S.-N. —

All the experiments on plants go to show that the sensibility of

the medium is strongest during the period in which the process of growth is at its maximum of intensity.

A stimulatory dose has frequently been demonstrated. — The inhibitory effect only appears after a couple of days (Period of latency).

As a rule, the death of the plant does not occur until a couple of weeks after irradiation.

The difficulty of ascertaining the exact degree of X-radiation by means of a decimeter is best shown by the investigations into the biological effects of filtered and unfiltered rays. The results of these investigations disagree to a marked extent. C. J. GAUS and LEMBCKE (1912), H. MEYER and RITTER (1912), ROST and KRÜGER (1913), KRÖNIG and FRIEDRICH (1918), have all found the biological effect to be more pronounced by strong filtration; while HOFFMANN, HOLTHUSEN and others have found that the strongest effect was obtained with unfiltered rays. And according to the most recent experiments made, in 1921, by FRIEDRICH, who used an iontometer with a small graphite chamber, the biological effect of identical doses should be the same whether filtered or not.

As a matter of fact the frequent assertion of a different biological effect from filtered and unfiltered rays is often misleading. If the intensity of that effect does not agree with the physical, chemical, or phototechnical measurements employed, the discrepancy is probably due, not to a stronger or slighter biological reaction to differently filtered rays, but to the untrustworthiness of the measuring-apparatus.

Our own investigations

Our first intention was to use Vicia Faba for these experiments, but at the advice of Professor JOHANNSEN, Director of the Plant-Physiological Laboratory of the University of Copenhagen, we decided, instead, on the Pisum sativum ("Victoria-pea"), which gives a very homogeneous material for experimental purposes, and the radicle of which is capable of easy and accurate measurement owing to its straight, perpendicular growth.

Germination of the peas

The peas are made to germinate by a method indicated by Prof. JOHANNSEN, as follows: After being thoroughly soaked, the peas are placed on a moistened block of plaster of Paris having a number of perforations just barely large enough to hold them, while a num-

ber of smaller, perpendicular canals opening on these larger ones serve to receive, each of them, the downward-growing radicle of the pea placed just above it (Figs. 1 and 2).

The plaster-of-Paris blocks are kept moist by being set in a dish filled with water to the depth of about 1 cm. All the blocks stood in one dish which, for our experiments, was placed in a thermostat, at a steady temperature of 20°. At this temperature we obtained a suitable growth of the radicles, enabling us to measure them during at least 4 × 24 hours.

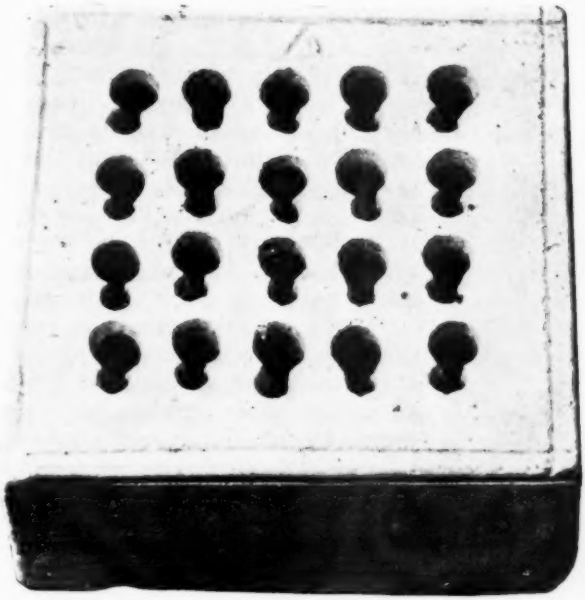


Fig. 1.

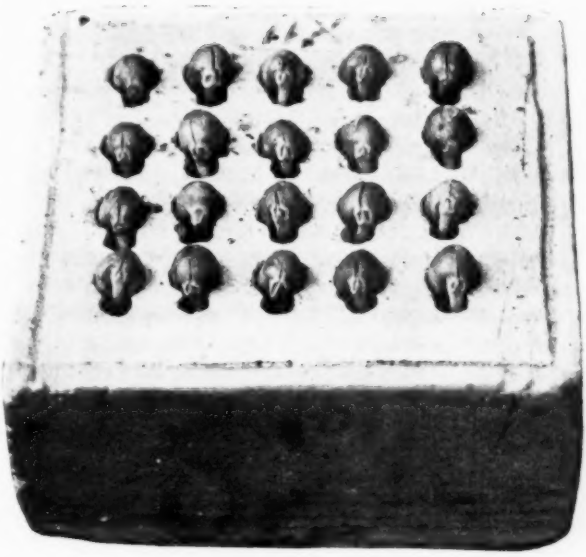


Fig. 2.

Measurement of the radicles

The method of measurement was as follows: The test of the pea is partially removed very carefully with a pair of pincers. By this operation two sharply cut furrows — the axis of the cotyledons — are laid bare,

just above the base of the radicle. In the peripheral edge of these furrows we have a fixed point, alike in all the peas. The distance from this point to the tip of the radicle, then, represents the length of the latter. — The measuring is done by pushing a piece of millimetre-paper up behind the radicle until its upper edge is level with the peripheral edge of the furrows. In most cases the tip of the radicle will then reach a point lying between two millimetre-lines on the paper, and the reading is then taken "up to" the one which has not yet been reached (Fig. 3). In measuring, great care must be taken not to damage the radicle.

Fig. 3.

When some orientating experiments had shown us that the sensibility of the peas to X-radiation was very much the same whether the irradiation took place 24 or 48 hours after soaking, we chose the latter period because, by so doing, we were enabled to measure the radicles immediately before irradiation and thus to assure ourselves of the material being truly homogenous, so that the variations in growth observed during the following days would be of real and unquestionable value.

Technique

Each experiment was carried out as follows:

1st day. — About 300 peas were placed in a flat dish filled with water to a depth of about $1^1/_2$ cm. The dish was placed in the thermostat.

2nd day. — The peas, which had now begun to germinate, were placed on moistened blocks of plaster-of-Paris in such a manner that they rested in the larger groove, the radicle of each pointing down into its separate, smaller canal. Any pea that appeared unhealthy (off-color, worm-eaten), or was not of the average size, was discarded.

In each experiment 200 peas were used: 100 for irradiation, and 100 as control.

Each plaster-of-Paris block was about 10×10 cm square, and 5 cm high, and would hold 20 peas. Thus, 10 blocks were used, altogether, and these were all stood in one dish of water, in the thermostat.

3rd day. — The radicles of all the peas were measured. In doing this, we took alternately one block of control peas and one block of the peas that were to be irradiated, so that the measuring

of the two sets of peas, each consisting of 5 blocks, was, as a matter of fact, done almost simultaneously. —

As soon as the measuring was done, one half of the peas were irradiated, each of the five blocks being exposed separately. —

During the exposure the peas were turned in such a manner that the radicles all lay horizontally. Particular care was taken that conditions should be absolutely identical for the two sets of peas. Thus, during the time of the exposure the control peas, also, were turned in a horizontal position.

4th day. — Measurement of all the radicles.

5th day. — Measurement of all the radicles.

6th day. — Measurement of all the radicles.

Afterwards, the mean average of growth per 24 hours was calculated by dividing the aggregate longitudinal growth of the radicles by the number of peas, separately for the irradiated and the non-irradiated set. The difference between the figures thus obtained expresses the biological effect of the dosage employed, as measured by the radicle of the pea.

It cannot be avoided that, in the course of an experiment, some of the peas will have to be thrown out. The radicle may be broken in the process of measuring, or in placing the pea in the block; or perhaps a few specimens may be found to be sickly, so that their growth ceases immediately after the radicle has begun to appear. The number of peas will therefore always be a little less at the termination of an experiment than at the beginning.

For the purpose of irradiation we used a Müller's water-cooled tube in connection with a JÆHRN's "symmetry induction coil". By means of a spectrometer the shortest length of the waves was determined as: 0.12 "ÅNGSTRÖM" units, equalling about 100 kilovolt.

The distance from the focus was calculated to the surface of the plaster-of-Paris block. As a rule, the irradiation was done from a distance of 23 cm, the distance being, of course, always the same throughout each series of experiments. As dosimeter, we used the Sabouraud-Noiré pastilles. This being the method most commonly in use at present, at least in the Scandinavian countries, we were, of course, particularly interested in testing its reliability. The reading of the pastille was done, besides by ourselves, by laboratory assistants who had for several years been daily engaged in this kind of work.

Sample of experiments

Our method of conducting the experiments will be best understood from the following schematic account of one of them:

The temperature in the thermostat was 20°.

1st day.

300 peas put in water to soak.

2nd day.

200 of those peas placed on moistened plaster-of-Paris blocks.

3rd day.

Measurement of all the radicles, and calculation of their mean average length by dividing the aggregate length by the number of peas. Figures obtained:

Peas to be irradiated:	Control-peas:
$\frac{843}{100} = 8.43$ mm.	$\frac{842}{100} = 8.42$ mm.

Immediately afterwards: Irradiation.

Dose: 1/2 S.-N. Distance: 23 cm. Filter: 1/2 mm Copper + 1 mm Aluminum.

4th day.

Measurement of all the radicles, and calculation of the mean average of longitudinal growth:

Irradiated peas:	Control-peas:
$\frac{1452}{100} = 14.52$	$\frac{1451}{99} = 14.66$
5th day.	
$\frac{1651}{98} = 16.82$	$\frac{1766}{97} = 18.21$
6th day.	
$\frac{1803}{96} = 18.78$	$\frac{2128}{94} = 22.65$

It will be seen that in this experiment the mean rate of growth is slightly less for the irradiated peas than for the control-peas. For the first 24 hours following irradiation, the difference is 0.14 mm; for the second 24-hour period it is 1.39 mm; and for the third

one 3.87 mm; giving a total difference, for the 3 × 24 hours, of 5.40 mm. In other words: 1/2 *S.-N. has, during the 3 × 24 hours following the irradiation, had an inhibitory effect amounting to 5.40 mm.*

After about ten trial-experiments — that is, after measuring about 2 000 peas — we had become sufficiently practiced in the measurement of the radicles to feel justified in attaching some real importance to the figures obtained. At the same time, we could not help being impressed with the splendid uniformity of the material furnished us in the Pisum sativum. This feature is clearly illustrated by the curve, Fig. 14, which was determined on the basis of 7 experiments by marking down, for each of the latter, as ordinate the mean average of growth during 3 × 24 hours after irradiation, and as abscissa the thickness of the aluminum filter. — In each experiment the peas were irradiated for 15 minutes, at 23 cm. The thermostat has been used 3 times; we have therefore had 3 control sets. The average length of the radicles, for these three sets, was, in the course of 3 days: 62.63, 63.68 and 63.71 mm. For figures as large as these, this must be said to be a very slight difference. —

For the calculation of the mean error, and for the size of the latter, see in the following, under "stimulation experiments". —

The full number of peas used in our experiments was about 18,000.

The first 3 series of experiments dealt with the effects obtained from various degrees of exposure, from the slightest upwards, partly without filter, partly with interposition of either 5 mm of aluminum or of 1/2 mm of copper + 1 mm of aluminum. The results of these various irradiations will be seen from the table below. For the sake of simplicity, the dosage is stated in fractions of Sabouraud. The figures indicate the difference in mean average of growth, between the irradiated peas and the control-peas, during 2 × 24 hours. A + before the figure indicates that the irradiated peas are longer than the control; a — that they are shorter.

Dose (S.-N.)	0	5 mm Al.	1/2 mm Cu. + 1 mm Al.
$\frac{1}{1080}$	− 0.37		
$\frac{1}{720}$	− 0.28		
$\frac{1}{360}$	− 0.33		− 0.23
$\frac{1}{84}$	− 0.56	+ 1.02	+ 1.65

Dose (S.-N.)	0	5 mm Al.	1/2 mm Cu. + 1 mm Al.
$\frac{1}{42}$	− 0.74	+ 2.17	+ 1.68
$\frac{1}{21}$	− 1.14	+ 1.46	− 0.66
$\frac{2}{21}$	+ 0.98	− 0.36	
$\frac{3}{21}$	− 1.99	− 0.79	
$\frac{8}{21}$		− 2.59	
$\frac{1}{2}$	− 3.33		− 5.40
1	− 6.24	− 3.05	− 8.00

A curious feature is the inhibitory effect of doses smaller than $^1/_{84}$ S.-N. The figures are so small, however, — only one of them being higher than that of the mean error — that *no definite importance can at present be attached to this circumstance.*

As regards the filtered rays, it is seen that doses of from $^1/_{84}$ S.-N. to $^1/_{21}$ S.-N. have had a stimulatory effect, the mean of increase being higher for the irradiated peas than for the control-peas. — Fig. 4 shows the curve of the irradiations through 5 mm al.

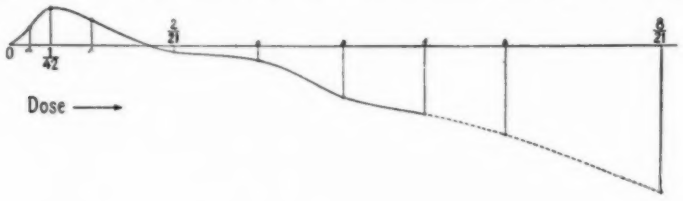


Fig. 4.

The stimulatory effect

We next made a closer investigation into the stimulatory effect of the exposures, by irradiating the radicles with doses of about $^1/_{42}$ S.-N. We quote below some of these experiments, which show an accelerated longitudinal growth of the radicles irradiated. The same technique was used as before.

Peas to be irradiated: $\frac{699}{92} = 7.6$ mm (mean average)

Control-peas: $\frac{711}{94} = 7.56$ mm

Irradiation: dose 1/42 S.-N., filter, 5 mm aluminum.

1st day: $\frac{1675}{84} = 19.94$ mm (mean average of growth) $\frac{1695}{91} = 18.62$ mm

2nd » : $\frac{1541}{80} = 19.26$ mm $\frac{1641}{90} = 18.23$ mm

3rd » : $\frac{1585}{77} = 20.58$ mm $\frac{1715}{84} = 20.42$ mm

Thus, the mean average growth of the irradiated radicles exceeded that of the control peas,

during the 1st day by 1.32 mm
» » 2nd » » 1.03 »
» » 3rd » » 0.16 »

Peas to be irradiated:	Control-peas:	Peas to be irradiated:	Control-peas:
$\frac{775}{95} = 8.16$	$\frac{797}{98} = 8.14$	$\frac{747}{98} = 7.63$	$\frac{768}{100} = 7.68$
1/42 S.-N. 5 mm Al.		1/42 S.-N. 5 mm Al.	
1st day: $\frac{2037}{92} = 22.14$	$\frac{1948}{94} = 20.72$	$\frac{1318}{93} = 14.17$	$\frac{1217}{98} = 12.95$
2nd » : $\frac{1582}{89} = 17.78$	$\frac{1677}{94} = 17.84$	$\frac{1542}{93} = 16.58$	$\frac{1554}{93} = 16.70$
3rd » : $\frac{1845}{87} = 21.21$	$\frac{1961}{91} = 21.55$	$\frac{1240}{90} = 13.78$	$\frac{1248}{90} = 13.87$
1st day: + 1.42 2nd » : − 0.06 3rd » : − 0.34		1st day: + 1.22 2nd » : − 0.12 3rd » : − 0.09	
$\frac{715}{96} = 7.45$	$\frac{683}{91} = 7.40$	$\frac{612}{87} = 7.00$	$\frac{633}{92} = 6.88$
1/42 S.-N. 1/2 mm Cu. 1 mm Al.		1/42 S.-N. 1/2 mm Cu. 1 mm Al.	
1st day: $\frac{1735}{94} = 18.46$	$\frac{1438}{84} = 17.12$	$\frac{1428}{85} = 16.80$	$\frac{1207}{83} = 14.54$
2nd » : $\frac{1925}{92} = 20.93$	$\frac{1528}{80} = 19.10$	$\frac{1904}{82} = 23.17$	$\frac{1851}{80} = 23.14$
3rd » : $\frac{1627}{87} = 18.70$	$\frac{1399}{75} = 18.75$	$\frac{1271}{78} = 16.29$	$\frac{1267}{78} = 16.24$
1st day: + 1.34 2nd » : + 1.83 3rd » : − 0.05		1st day: + 2.26 2nd » : + 0.03 3rd » : + 0.05	

That, with suitable dosage, a stimulatory effect can be produced, is further proved by the following table, which shows the strength of that effect, during the first 24 hours, together with the mean error.

Dose:	Filter:	Stimulation:	Mean error:
1/42	5 mm Al.	1.32 mm	0.5628
1/42	—	1.42 »	0.4451
1/21	—	1.22 »	0.3923
1/42	1/2 mm Cu. + 1 mm Al.	1.34 »	0.4688
1/84	— —	2.26 »	0.4985

Computation of mean error

As already stated, the degree of stimulation is expressed by the difference between the growth of, respectively, the irradiated peas and the control-peas. The mean error of this difference is computed according to the formula: $m_{\text{diff.}} = \sqrt{m_1^2 + m_2^2}$, m_1^2 and m_2^2 being the mean error for the average of growth of, respectively, the control-peas and the irradiated ones (m_1, resp. $m_2 = \frac{\text{Standard division}}{\sqrt{n}}$). The method employed is the one described by JOHANNSEN (Erblichkeitslehre, p. 54.)

The table shows the difference, in each instance, to be so many times larger than the mean error that it cannot possibly be accidental. It is real; and it proves conclusively that the X-ray doses here indicated have accelerated the longitudinal growth of the radicles.

During these experiments we invariably found that the stimulatory effect could be demonstrated during the first period of 24 hours, and sometimes also during the second one, but from that time it ceased. During the third day the average rate of growth was, in most cases, slightly less for the irradiated peas than for the control-peas.

Thus, the stimulatory effect is without doubt a merely transient one, quickly produced and as quickly passing away.

On no occasion did we succeed, when planting out the peas in which the stimulating effect of irradiation had been plainly manifest on the radicle, in observing any earlier appearance of the shoot, or stronger growth of the stem, as compared with that of the control specimens. To produce a "giant growth" by means of X-irradiation with a stimulatory dose is therefore unquestionable beyond the range of possibility.

Medical Science Department.

The stimulatory dose lies between $^1/_{84}$ *and* $^1/_{21}$ *S.-N., inclusively.* With filtered rays we were able to produce the stimulatory effect whenever desired. With unfiltered rays the task was far more difficult, possibly because with these the time of exposure, even at a considerable distance, is only a few seconds, which makes it difficult to regulate the dosage correctly.

Effect of inhibitory doses

On investigating the effects of such large doses as 2, 4, 6, and 8 S.-N. we found their inhibitory effect on the growth of the radicles so marked that we were able to use a smaller number of peas for each irradiation.

In the following experiment there were 40 peas to each set, to begin with.

Filter: 5 mm Al. Distance: 23 cm

	Control:	2 S.-N.	4 S.-N.	6 S.-N.	8 S.-N.
1st day:	$\frac{670}{39} = 17.11$	$\frac{523}{38} = 13.76$	$\frac{503}{38} = 13.24$	$\frac{337}{32} = 10.59$	$\frac{299}{31} = 9.65$
2nd day:	$\frac{608}{39} = 15.59$	$\frac{424}{37} = 11.46$	$\frac{350}{38} = 9.21$	$\frac{250}{32} = 7.81$	$\frac{228}{31} = 7.35$
3rd day:	$\frac{518}{36} = 14.39$	$\frac{368}{36} = 10.22$	$\frac{302}{38} = 5.32$	$\frac{136}{32} = 4.25$	$\frac{96}{30} = 3.20$
	47.09 mm	35.44 mm	27.77 mm	22.65 mm	20.20 mm

Comparison with the control gives:

	2 S.-N.	4 S.-N.	6 S.-N.	8 S.-N.
1st day:	− 3.35	− 3.87	− 6.52	− 7.46
2nd » :	− 4.13	− 6.38	− 7.78	− 8.24
3rd » :	− 4.17	− 9.07	−10.14	−11.19
	−11.65	−19.32	−24.44	−26.89

Fig. 5. 8 days after planting.

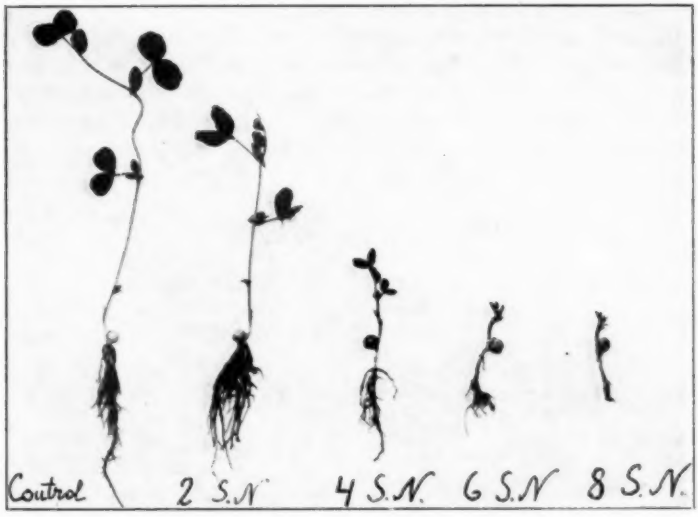


Fig. 6. Plants taken from the boxes.

It will be seen from this experiment that doses of 4, 6, and 8 S.-N. do not have an immediately destroying effect on the germinating peas. The radicles continue to grow after the exposure, but their longitudinal growth becomes less every day. A period of latency such as many investigators have stated precedes the effect of large inhibitory doses, has not been observed by us. The inhibitory effect was marked already during the first 24 hours.

When the peas had been planted out, the appearance of the stem occurred at almost the same time for the different sets. For two or three days the stems of the irradiated ones remained behind those of the control-peas, and about five days after planting the growth of the stem ceased completely in the peas that had been exposed to dosages of 6 and 8 S.-N.

Death of the peas

Thus, a period of latency can be spoken of *only where the full effect of the large, inhibitory doses is being observed*, because the death of the pea does not occur until about 8 days after the irradiation has taken place. When a period of latency is mentioned by so many investigators in connection with the inhibitory doses, it is

undoubtedly due to the fact that, almost without exception, they have planted the seeds immediately after irradiation, without first examining the root.

The peas that had been exposed to irradiation with doses of 2 and 4 S.-N., filtered through 5 mm of aluminium, were all far behind the control, but the stems continued to grow. The X-radiation had resulted in a thorough change as regards the appearance of the plants. Their leaves were not of the same light green as those of the control, but were darker, brownish and shrivelled.

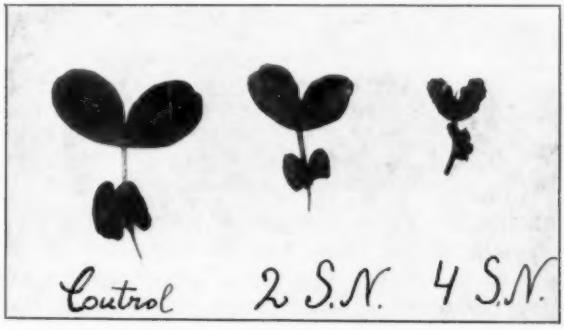


Fig. 7.

The whole plant had a sickly look, which persisted for about four or five weeks and then gradually disappeared. Little by little, the difference between these plants and the control-plants became less and less marked, and after some six or eight weeks' time their appearance was entirely normal.

Divided doses

We next investigated the effect of divided doses, in order to see whether a certain dose given in one exposure would produce a stronger or slighter inhibitory effect than would the same dose administered in a series of successive exposures.

The two following tables show two of these experiments, one with small doses, the other with large ones. The hours at which irradiation took place were chosen in such a manner that the full dose was given exactly at half-time between the first and last of the divided ones.

		$\frac{852}{100} = 8.52$ mm	$\frac{852}{100} = 8.52$ mm
Filter: 5 mm Al. *Distance:* 23 cm.	*Dose:* 1 S.-N. at 2 p. m.		8 a. m.: 1/4 S.-N. 12 noon: 1/4 » 4 p. m.: 1/4 » 8 p. m.: 1/4 »
	1st day:	$\frac{1468}{99} = 14.82$	$\frac{1389}{95} = 14.68$
	2nd » :	$\frac{1817}{93} = 19.53$	$\frac{1936}{90} = 21.51$
	3rd » :	$\frac{1572}{92} = 17.09$	$\frac{1650}{88} = 18.75$
		51.44 mm	54.94 mm

A comparison of the final figures show the 3 days' growth resulting from the single, full exposure to have been less, by 3.50 mm, than the growth resulting from the same dose administered fractionally in 4 times 1/4 S.-N.

After planting, no difference was observed. The appearance and subsequent growth of the stem was the same for all the peas.

In the higher, inhibitory degrees of exposure the stronger effect of the undivided dose is even more pronounced, as will be seen from the following experiments:

		$\frac{381}{60} = 6.35$ mm	$\frac{382}{60} = 6.37$ mm	$\frac{377}{60} = 6.28$ mm
Filter: 2 mm Al. *Distance:* 33 cm	*Doses:*	8 p. m. 1 S.-N. 8 a. m. 1 » 8 p. m. 1 »	8 p. m. 1 1/2 S.-N. 8 p. m. 1 1/2 »	8 a. m. 3 S.-N.
	1st day:	$\frac{887}{58} = 15.29$	$\frac{853}{56} = 15.23$	$\frac{828}{58} = 14.28$
	2nd day:	$\frac{992}{58} = 17.10$	$\frac{889}{55} = 16.46$	$\frac{891}{57} = 15.63$
	3rd day:	$\frac{823}{58} = 14.18$	$\frac{744}{53} = 14.34$	$\frac{512}{57} = 8.98$
	4th day:	$\frac{527}{58} = 9.56$	$\frac{532}{52} = 10.23$	$\frac{319}{57} = 5.42$
		56.13 mm	56.26 mm	44.31 mm

If we compare the figures for the mean average of growth in the 4 × 24 hours after irradiation, it will be seen that the radicles that had been submitted to a single exposure only, with dosage 3 S.-N., show a growth of about 12 mm less than either of the two

other sets, where the exposure had been divided in, respectively 3×1 S.-N. and $2 \times 1^1/_2$ S.-N.

After the peas had been planted, there was a noticeable difference between the three sets; the growth of the stem being feeblest in those which had been given only one exposure, and strongest in those where the three fractional doses had been given.

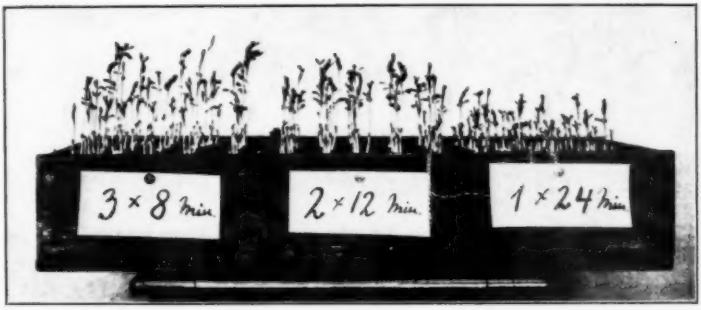


Fig. 8.

In all the 5 experiments made with divided doses, the strongest inhibitory effect was observed on those radicles which had been submitted to the full dose in a single exposure. In those of the experiments where that dose was higher than $1^1/_2$ S.-N. we further observed, after the peas had been planted, an inferior growth of those which had received the dose undivided.

Influence of different filters on biological effect of the X rays

A series of experiments were made for the purpose of investigating whether the biological effect of a given S.-N. dose was the same irrespectively of the kind of filter used. These experiments were made with four sets of peas, one of which served as control, while the others were exposed, respectively, (1) to the unfiltered X rays, (2) to rays filtered through 5 mm of aluminum, and (3) to rays filtered through $^1/_2$ mm of copper + 1 mm of aluminum. The distance from the focus was 23 cm, the temperature in the thermostat 21°.

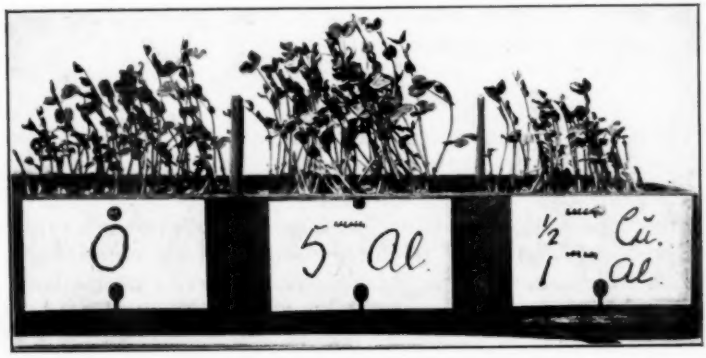
The experiments showed very plainly that irradiation through 5 mm of aluminum did not produce nearly as inhibitory an effect as irradiation either unfiltered or through $^1/_2$ Cu. + 1 Al.

The following tables show 3 experiments, with doses of, respectively, 1, 2 and 3 S.-N. In the first of these experiments, the number of peas in each of the irradiated sets was 60, in the control-set 20.

	No filter:	5 mm Al.:	½ mm Cu. + 1 mm Al.:	Control:
	$\frac{502}{60} = 8.37$	$\frac{502}{60} = 8.37$	$\frac{500}{60} = 8{,}33$	$\frac{167}{20} = 8.35$
	1 S.-N.	1 S.-N.	1 S.-N.	
1st day:	$\frac{788}{58} = 13.59$	$\frac{841}{58} = 14.50$	$\frac{750}{55} = 13.64$	$\frac{228}{18} = 16.56$
2nd day:	$\frac{821}{57} = 14.40$	$\frac{942}{56} = 16.82$	$\frac{708}{50} = 14.16$	$\frac{333}{18} = 18.50$
3rd day:	$\frac{674}{57} = 11.82$	$\frac{1023}{55} = 18.60$	$\frac{534}{49} = 10.90$	$\frac{381}{16} = 23.81$
	39.81 mm	49.92 mm	38.70 mm	58.87 mm

A comparison with the control gives the following figures for the inhibitory effect:

	No filter:	5 mm Al.	½ mm Cu. + 1 mm Al.
1st day:	2.97	2.06	2.92
2nd »	4.10	1.68	4.34
3rd »	11.99	5.21	12.91
	19.06 mm	8.95 mm	20.17 mm



1 S.-N.

Fig. 9.

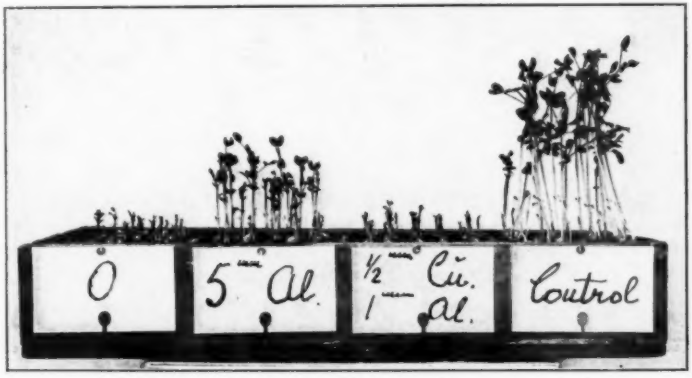
The peas were set out immediately after the last measurement. Fig. 9 shows the size of the plants 8 days after planting.

The two following experiments were made with 40 peas to each set.

	No filter:	5 mm Al.:	½ mm Cu. + 1 mm Al.:	Control:
	$\frac{358}{40} = 8.95$	$\frac{357}{40} = 8.93$	$\frac{360}{40} = 9.00$	$\frac{358}{40} = 8.95$
	2 S.-N.	2 S.-N.	2 S.-N.	
1st day:	$\frac{508}{38} = 13.37$	$\frac{576}{38} = 15.16$	$\frac{439}{38} = 11.55$	$\frac{600}{39} = 15.38$
2nd »	$\frac{288}{37} = 7.78$	$\frac{438}{37} = 11.84$	$\frac{353}{37} = 9.54$	$\frac{651}{37} = 17.59$
3rd »	$\frac{157}{37} = 4.24$	$\frac{315}{35} = 9.00$	$\frac{200}{36} = 5.56$	$\frac{573}{34} = 16.85$
	25.39 mm	36.00 mm	26.65 mm	49.82 mm

Inhibition as compared with the control:

	No filter:	5 mm Al.	½ mm Cu. + 1 mm Al.
1st day:	2.01	0.22	3.83
2nd »	9.81	5.75	8.05
3rd »	12.61	7.85	11.29
	24.43 mm	13.82 mm	23.17 mm



2 S.-N.

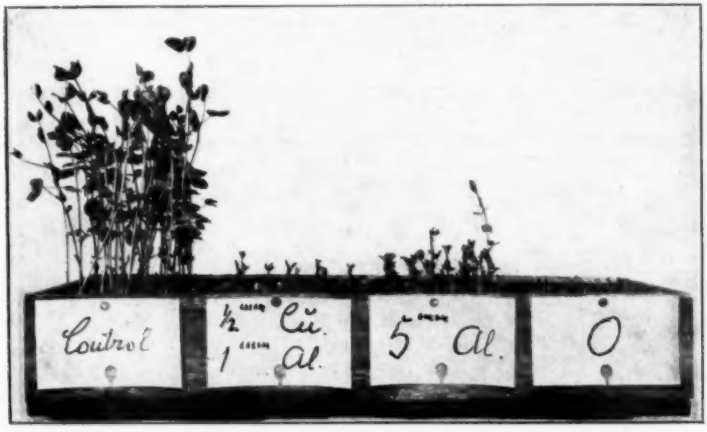
Fig. 10.

Fig. 10 shows the size of the plants 8 days after the peas had been put in the soil.

	No filter:	5 mm Al.:	½ mm Cu. + 1 mm Al.:	Control:
	$\frac{365}{40} = 9.13$	$\frac{365}{40} = 9.13$	$\frac{365}{40} = 9.13$	$\frac{365}{40} = 9.13$
	3 S.-N.	3 S.-N.	3 S.-N.	
1st day:	$\frac{504}{40} = 12.60$	$\frac{580}{38} = 15.26$	$\frac{502}{38} = 13.21$	$\frac{700}{40} = 17.50$
2nd »	$\frac{287}{40} = 7.18$	$\frac{374}{38} = 9.84$	$\frac{522}{38} = 8.47$	$\frac{708}{40} = 17.70$
3rd »	$\frac{129}{40} = 3.23$	$\frac{157}{37} = 4.24$	$\frac{142}{38} = 3.74$	$\frac{859}{40} = 21.48$
	23.01 mm	29.34 mm	25.42 mm	56.68 mm

Inhibition, as compared with the control:

	No filter:	5 mm Al.	½ mm Cu. + 1 mm Al.
1st day:	4.90	2.24	4.29
2nd »	10.52	7.86	9.23
3rd »	18.25	17.24	17.74
	33.67 mm	27.34 mm	31.26 mm



3 S.-N.

Fig. 11.

Fig. 11 shows the size of the plants 8 days after planting.

From these experiments it will be seen that the inhibition is considerably less for the peas exposed through 5 mm Al. than for those exposed either directly or through ½ mm Cu. + 1 mm Al.

The destructive dose, for the peas, is: with exposure through 5 mm Al., about 5 S.-N.; with direct exposure or through $^1/_2$ *Cu.* + *1 Al., a little less than 3 S.-N.*

Comparison of dosimeters

Shortly after we had commenced our experiments, the Hospital bought a SOLOMON's Iontometer. We then took occasion to compare the measurements for the Sabouraud Pastille, this Iontometer and a FÜRSTENAU's Intensimeter, as shown in the following table:

Filter:	*S.-N. Pastilles* No. of minutes for 1 S.-N.	*Iontometer* No. of seconds for 10 E.	*Intensimeter* Number of F.
None	$3^1/_2$—4	13	9.25
5 mm Al.	$7^1/_2$—8	42	4
$^1/_2$ mm Cu. + 1 mm Al. .	24	75	1.8

It will be seen that the time it took to administer 1 S.-N. through 5 mm Al. was surprisingly short, while the times for, respectively, the unfiltered exposure and the exposure through $^1/_2$ mm Cu. + 1 mm Al. are more or less the same.

We next examined the time for the S.-N. pastille with various thicknesses of filter interposed, all the way from 0 to 12 mm Al. In order to guard against any possible influence from the intense heat resulting from such great thicknesses of filter, we fastened a 1 mm aluminum filter to the tube-box, at a distance of 15 cm from the focus, and slid the other filters in behind that first one each time it was desired to increase the total thickness of the layer. The pastille was placed 2 cm below the lowest filter, at a total distance of 17 cm from the focus.

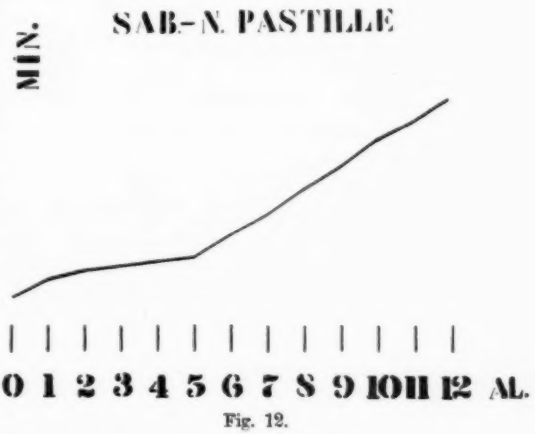


Fig. 12.

Min.	6	10	12	13	14	15	20	24	30	35	41	45	50
Filter.	0	1	2	3	4	5	6	7	8	9	10	11	12

Fig. 12 shows the curve. The thickness of the filter is marked along the axis of the abscissa, and the number of minutes which

it took for the color of the pastille to change under various filtration along the axis of the ordinate. The portion of the curve from 0 to 9 mm Al. was determined on the basis of 5 separate series of experiments.

Following this, we took the readings of the electroscope, with from 0 to 12 mm Al., by means of SOLOMON's Iontometer. The resulting curve will be seen as the lower one of the two represented in Fig. 13.

Sec.	12	18	24	28	33	37	40	45	50	56	60	66	70
Filter	0	1	2	3	4	5	6	7	8	9	10	11	12

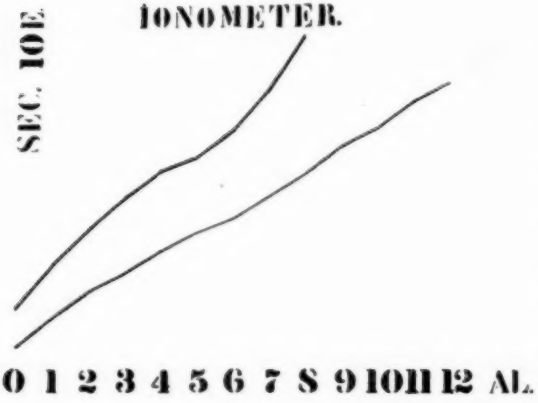


Fig. 13.

As the radicles of the peas offered so excellent a standard of measurement we decided to investigate, at the same time, the biological effect of exposure through different thicknesses of filter, all the way from nil to 11 mm Al. Each set of peas was exposed for 15 minutes at 23 cm, and the measurements taken during the three following days gave:

	0 Filter	1 mm Al.	3 mm. Al.	5 mm Al.	7 mm Al.	9 mm Al.	11 mm Al.
1st day:	15.26	15.13	15.90	15.18	15.75	15.89	16.15
2nd »	14.57	15.58	16.72	17.15	17.58	19.65	20.37
3rd »	6.61	9.03	11.71	15.69	18.33	18.79	23.14
Total:	36.44 mm	39.74 mm	44.33 mm	48.02 mm	51.66 mm	54.33 mm	59.66 mm

The experiment was made with 40 peas to each set, and the figures represent the mean of growth. It will be noticed how the inhibitory effect of the exposure, on the radicles submitted to the stronger doses (0 Filter, 1 mm Al. and 3 mm Al.), did not manifest itself in any marked degree until the third day. The curve, Fig. 14, is determined on the basis of the aggregate mean of growth for the three days.

The result of this experiment points to the conclusion that *the color of the Sabouraud pastille changes too rapidly when only medium-thin layers of filter are used*, and that therefore the dose actually administered has no true relation to the measure recorded of the exposure.

The cause of this too rapid alteration of color is undoubtedly to be found in the composition of the pastille itself, which consists of platino-cyanide of barium. Several authors, already, have pointed out that under certain conditions the discontinuity of absorption, of the barium and — possibly — the platinum, would cause the color to change too rapidly.

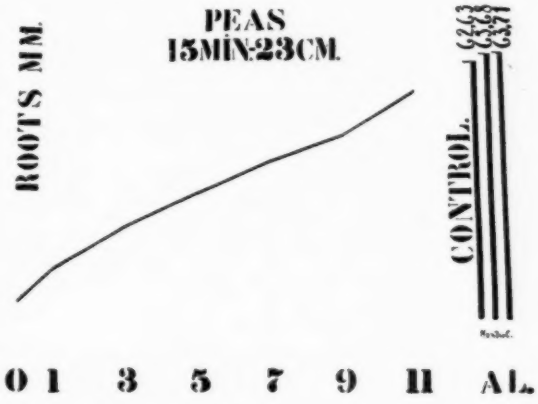


Fig. 14.

When the X rays strike a body some of them become absorbed, and the coefficient of absorption will be continually smaller as the wave-length becomes shorter. Not thus, however, with the substances where there is a discontinuity in the absorption. For these, the coefficient of the absorption will, with diminishing wave-length, rise abruptly to a maximum, then evenly, gradually decrease, as shown in Fig. 15, which represents — in a purely schematic fashion — the absorption curve for barium.

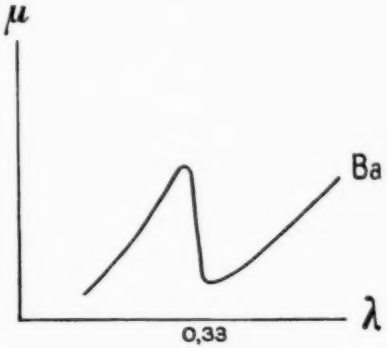


Fig. 15.

For barium, the steep rise in the curve occurs at about 0.33 Å. E.; for platinum at about 0.16 Å. E.

This suddenly increased absorption is due, as we know, to the characteristic radiation of those substances themselves, to produce which we must operate, in the primary rays, with waves that are shorter than the waves of that characteristic radiation itself. For barium, as already stated, we get the strongest discontinuity with wave-lengths just barely shorter than

0.33 Å. E. As the length of the waves is shortened the discontinuity will play a gradually slighter rôle, and will end by ceasing entirely. With X rays having a wave-length of more than 0.33 Å. E. there is no risk of any discontinuity in the absorption. But, as already stated, the shortest wave-length, of the primary rays, measured in connection with this investigation of ours was between 0.12 and 0.13 Å. E.; consequently, it is possible that the result, in our case, has been influenced by the discontinuity of absorption, both of the barium and the platinum.

If, now, we look at the curve for the Sabouraud Pastille (Fig. 12), it would appear that we have had to do with an increased absorption in connection with the filtrations from 1 mm up to about 6 mm Al. Theoretically, we should be fairly beyond any interference from the discontinuity of the barium from 8 mm Al. upwards, and the discontinuity of the platinum would only have become safely eliminated with the use of about 11 mm Al. filter. There can be no doubt, therefore, that it is the discontinuity of absorption, of the barium, to which must be ascribed the too rapid change in the color of the pastille when the thinner filters were used.

In order to test still further the correctness of this theory, we have tried to prove the characteristic radiation of the pastilles by means of the Iontometer. We enclosed the ionisation chamber in a piece of the pastille paper, with the platino-cyanide side of the latter toward the chamber, and on noting the time registered by the electroscope for from 0 to 10 mm Al. we now discovered the presence of a new factor, which resulted in a curve (shown as the upper one in Fig. 13) entirely different from the almost straight line previously recorded.

To make the curves for the Sabouraud Pastilles, the Iontometer and the peas correspond under the different conditions of filtration, it would be necessary that the administration of 1 S.-N., through 5 mm Al. at 23 cm, should take 13 minutes instead of, as now, only $7^1/_2$ min. *Consequently, through 5 mm Al. we are only administering a dose a little more than half as large as the one we have measured.*

The thickness of filter with which the pastille will make its discontinuity of absorption most markedly felt will not always be the same, but will depend upon the greater or lesser intensity of action of the particular apparatus used. And for this reason alone a comparison of the dose measured in S.-N. will be extremely difficult.

To the practiced operator the comparison of the pastille with the standard tint is not a matter of great difficulty, and may be safely relied upon, as we have had occasion to experience time and again

in the course of these investigations. The pastille, therefore, is a perfectly serviceable means of controlling the regular functioning of an apparatus, that is, the invariable intensity of its action, from one day to another. But as a final standard for measuring the degree of exposure it is of no value at all.

The curve for the Iontometer and the one for the peas are almost identical, which is as much as to say that *the biological effect, as measured by the radicles during 3 × 24 hours, is in proportion to the ionisation effect as measured on our Iontometer, independently of the filtration.*

In conclusion, we desire to express our thanks to Dr. H. J. Panner M. D. for the great interest he has shown in this work of ours, to Prof. H. M. Hansen, of the Polytechnical Institute, for much valuable assistance, and, last not least, to Mr Boysen Jensen, Ph. D., for his great and untiring helpfulness in connection with the many different problems concerning the peas.

SUMMARY

The experiments were on Pisum sativum ("Victoria-peas").

As measure for the biological effect of the X rays we used the radicle, which has a straight perpendicular growth and is very easy to measure by means of a piece of millimetre-paper.

An absolute, stimulatory effect has been proved to result from doses of about 1/42 S.-N. The stimulation could be demonstrated for the first, and in some instances for the second period of twenty-four hours after exposure, but after that time it ceased.

A single, full exposure produced a stronger biological effect than the same dosage administered in a series of "divided doses".

The full effect of large inhibitory doses does not make itself felt until several days after the exposure.

When the Sabouraud Noiré Pastille was used to check the exposures, the biological effect to the X rays filtered through 5 mm of aluminum was only half as great as the effect of either the unfiltered rays or the rays filtered through 1/2 mm of copper + 1 mm of aluminum. This is due to the pastille's discontinuity of absorption.

The biological effect, as measured on the radicles of the peas during 3 × 24 hours after irradiation, is in proportion to the ionisation effect, independently of the filtration.

ZUSAMMENFASSUNG

Die Versuche wurden an Pisum sativum (»Victoria-Erbsen«) angestellt.

Als Mass für die biologische Wirkung der X-Strahlen benützten wir die Wurzel, die ein gerades senkrechtes Wachstum hat und mit Hilfe eines Millimeterpapiers sehr leicht zu messen ist.

Bei Dosen von ungefähr 1/42 S.-N. wurde ein sicherer reizender Effekt konstatiert. Die Reizung war für die erste, und in manchen Fällen für die zweite Hälfte einer 24-stündigen Periode nach der Exposition nachweisbar, nach dieser Zeit aber hörte sie auf.

Eine einzige volle Dosis rief eine stärkere biologische Wirkung hervor, als dieselbe Gabe in dosi refracta.

Der volle Effekt von grossen hemmenden Dosen macht sich erst mehrere Tage nach der Exposition kenntlich.

Bei Benützung von Sabouraud-Noiré-Pastillen zur Kontrolle der Exposition war die biologische Wirkung der durch 5 mm Aluminium filtrierten X-Strahlen nur halb so gross als die von unfiltrierten Strahlen oder von Strahlen, die ein 1/2 mm Kupfer + 1 mm Aluminium passiert hatten. Dies beruht auf der Diskontinuität der Absorption durch die Pastille.

Der biologische Effekt, gemessen an den Wurzeln der Erbsen durch 3 × 24 Stunden nach der Bestrahlung, ist proportional dem Ionisationseffekt, unabhängig von der Filtration.

RÉSUMÉ

Les expériences se faisaient sur le Pisum Sativum (»Victoria-peas»).

Comme mesure de l'effet biologique des Rayons X nous avons employé la racine, qui a une croissance perpendiculaire et droite, et qui est très facile à mesurer à l'aide d'un morceau de papier à millimètres.

Un effet stimulant certain résultait de doses d'environ 1/42 S.-N. La stimulation a pu être démontrée pour la première et dans quelques cas pour la seconde période de 24 heures d'exposition, mais après ce laps de temps elle cessait.

Une seule entière exposition produisit un effet biologique plus fort que la même dose administrée en série de »doses fractionnées».

Le plein effet de grandes doses inhibitrices ne se fait sentir que plusieurs jours après l'exposition.

Quand la pastille Sabouraud-Noiré était employée pour intercepter l'exposition, l'effet biologique des Rayons X filtrés par 5 mm d'aluminium n'était que moitié si fort que l'effet des rayons non filtrés ou des rayons filtrés par 1/2 mm de cuivre + 1 mm d'aluminium. Ceci est dû à la discontinuité d'absorption de la pastille.

L'effet biologique mesuré sur les racines des pois pendant 3 × 24 heures après l'irradiation, est proportionnel à l'effet d'ionisation, indépendemment de la filtration.

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ETUDE SUR LA MUQUEUSE GASTRO-INTESTINALE APRÈS GASTRO-ENTÉROANASTOMOSE

par

H. Hellmer

(Tabulæ I—XV)

Les études du Prof. FORSSELL [1] sur le mécanisme du mouvement de la muqueuse du canal digestif nous ont ouvert de nouveaux horizons sur l'anatomie et la physiologie de ce canal. Le mouvement de la muqueuse ellemême, facteur jusqu'ici négligé dans le mécanisme de la digestion, s'impose de plus en plus à notre attention.

La morphologie et la physiologie de la gastro-entéroanastomose [2] se présentent au premier plan des questions actuellement étudiées à l'Institut Radiologique de l'hôpital des Séraphins à Stockholm. Depuis longtemps cette question a soulevé l'intérêt des chirurgiens comme des radiologues. Les opinions ont été divergentes, parfois contraires. Tandis que certains ne voyaient dans la gastro-entérostomie qu'un simple draînage de l'intestin, d'autres [3] attribuaient au canal digestif une possibilité d'adaptation telle, qu'ils croyaient voir apparaître un nouveau sphincter à la bouche anastomatique. Depuis, des études anatomiques ont fait table rase des opinions extrêmes; mais la question suivante se pose toujours: *Cette discontinuité de l'évacuation stomacale à travers l'anastomose, si souvent observée et citée dans la littérature*[4], *de quoi dépend-elle?*

[1] G. FORSSELL, »Ueber die Beziehung der Röntgenbilder des menschlichen Magens zu seinem anatomischen Bau», pages 133—151. Fortschritte auf dem Gebiete der Röntgenstrahlen, Hambourg 1913.

G. FORSSELL, »Studies of the mechanism of movement of the mucous membrane of the digestive tract». The american journal of roentgenology and radium therapy. Février 1923.

[2] J'ai employé le terme *gastro-entéroanastomose* pour qualifier toute communication opératoire entre l'estomac et l'intestin, qu'il y ait eu ou non résection de l'estomac.

[3] CARLE et FANTINO, »Beitrag zur Pathologie und Therapie des Magens». Archiv für klinische Chirurgie, Volume 56 (1898), page 33.

[4] HÄRTEL. »Die Gastroenterostomie im Roentgenbilde». Deutsche Zeitschrift für Chirurgie. Vol. 109 (1911), page 336.

O. HESSE, »Die Gastroenterostomie im Roentgenbilde.» Zeitschrift für Roentgenkunde. Vol. 14 (1912), page 202.

SCHÜLLER, »Funktion des Magens nach Gastroenterostomie und Pylorusresektion». Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie. Vol. 22, page 737.

HARTMANN, »The function of the gastro-enterostomy opening in cases of permeable pylorus». Annals of surgery 1914 (page 839).

On a allégué les ondes péristaltiques de l'estomac[1], et de l'anse grêle sous-jacente[2]; de plus, la pression variable causée, dans la cavité abdominale, par la respiration[3].

Cette divergence d'opinion est causée par la difficulté à observer l'orifice anastomatique sur la plaque radiographique ou l'écran radioscopique, avec les méthodes d'examen dont nous avons disposé jusqu'ici. A ce propos je me permets de citer l'opinion que FORSSELL exprima à Stockholm en 1923, à la 3e réunion de «Nordisk Förening för medicinsk radiologi», pendant une discussion sur l'ulcère peptique jéjunal[4]: «First of all I want to point out that we do not yet know sufficiently in detail the *normal Roentgen picture* of the gastro-enterostomy and of the jejunal loop close to it» ..... «We do not know as yet to what extent the folds in the neighbourhood of a gastro-enteroanastomosis are *normally varying* under different conditions, and therefore we are not able to decide with any certainty what kinds of contraction are pathologic.»

Cette difficulté dans l'étude du fonctionnement des gastro-entéroanastomoses dépend de facteurs différents: le passage rapide à travers l'anastomose, le fait que cette anastomose, ainsi que les parties les plus rapprochées de l'intestin grêle, sont souvent cachées par l'ombre gastrique. De plus le repas opaque type, en provoquant souvent une image noire compacte, empêche toute observation des altérations légères, qui pourraient siéger sur les parois antérieures ou postérieures de l'estomac.

En 1923, l'américain RENDICH[5] publia une méthode d'examen radiologique qui a considérablement diminué cette difficulté. Il fait prendre au malade un repas, composé de 2 à 3 cuillerées d'un mélange à parties égales de solution de gomme à 50 % et de sulfate de baryte; dans la position couchée ou demie-assise, la bouillie coule lentement le long de la paroi postérieure de l'estomac qui en est pour ainsi dire tapissée. Après ce que nous avons dit plus haut il est facile de voir d'emblée les avantages de cette méthode dans toute étude de gastro-entéroanastomose. Un des désavantages est que les conditions fonctionnelles n'en sont pas tout à fait comparables à celles provoquées par un repas ordinaire dont les 2 ou 3 cuillerées absorbées, ne sont qu'une petite partie

[1] HÄRTEL, Ouvrage cité ci-dessus, page 336.
O. HESSE, id. page 203.
[2] SCHÜLLER, id. page 752.
HESSE, id. page 203.
[3] SCHÜLLER, id. page 737.
[4] *Acta Radiologica* Vol. III, fascicule 2—3, page 223.
[5] The American Journal of Roentgenology and Radium Therapy. Juillet 1923.

Il sera toujours nécessaire de compléter cet examen par un autre fait à l'aide du repas opaque (selon FORSSELL). De plus, FORSSELL propose de faire tenir le malade debout à la fin de l'examen d'après RENDICH dans le but de faire travailler encore plus la bouche anastomatique, quand elle est située relativement en bas de l'estomac.

Depuis fin 1923, j'ai procédé, de cette manière, à l'examen d'un certain nombre d'estomacs portant une gastro-entéroanastomose. La plupart des examens ont été faits à l'Institut de l'hôpital des Séraphins, un petit nombre à l'hôpital de Sabbatsberg et à l'hôpital de la province de Stockholm à Stocksund. De plus le professeur FORSSELL a eu la bonté de me permettre de prendre connaissance des examens de même sorte faits dans son institut privé. J'ai déjà publié en partie les résultats de mes observations, d'abord à la réunion de «Svenska Föreningen för medicinsk radiologi» en février 1924, puis comme contribution dans la discussion qui eut lieu dans l'Assemblée des chirurgiens suédois, en novembre de la même année.

J'ai trouvé certaines altérations du relief de la muqueuse sur la gastro-entéroanastomose, et sur le côté de l'estomac, et sur celui de l'intestin grêle. Les altérations sont indépendantes soit du siège de la gastro-entérostomie, soit du mode de l'opération (termino-terminale, termino-latérale, latéro-latérale). Suivant l'endroit de l'estomac où l'anastomose est placée, il est possible de distinguer certains types caractéristiques; mais ces types présentent des caractères communs donnant leur empreinte sur la morphologie de l'anastomose et influençant probablement sa fonction.

La configuration de la surface interne d'un estomac ou d'un intestin normal est constituée par les reliefs de sa muqueuse. FORSSELL a démontré [1] que ces plis varient en nombre, forme et dimension et que leur apparition dépend d'une activité de la muqueuse même. Il est impossible pour le moment de savoir si cette activité vient de la musculaire-muqueuse, ou si elle se propage grâce à différents degrés d'afflux dans les vaisseaux. FORSSELL [2] a prouvé qu'il existe des signes non douteux de contraction de la musculaire-muqueuse au sommet des plis, ceci en examinant des préparations de tissus d'animaux et d'individus.

Les reliefs de la muqueuse se profilent très nettement dans les radiogrammes obtenus d'après la méthode RENDICH (fig. 1). Nous y voyons, comment la direction principale des plis, est, somme toute,

[1] G. FORSSELL, »Ueber die Beziehungen der Roentgenbilder etc.», page 151.
G. FORSSELL, »Studies of the mechanism of movement etc.»

[2] Conférence tenue à l'Académie des sciences de Suède le 26 nov. 1924 et à la Réunion des Chirurgiens Suédois le 29 nov. 1924».

parallèle à l'axe longitudinal de l'estomac. Dans le fornix et les parties latérales du corpus, nous voyons des plis obliques et transversaux unissant les plis longitudinaux plus accusés. Mais si nous examinons un estomac muni d'une gastro-entérostomie nous voyons une toute autre image: *les plis s'assemblent nombreux autour du nouvel orifice, affectant une direction convergeant vers cet orifice.*

Il en résulte une altération des reliefs ordinaires de la muqueuse, laquelle altération est plus ou moins profonde en partie suivant le siège de l'anastomose.

A la résection et quand le lumen de l'estomac a été employé (en entier ou en partie) comme orifice d'anastomose, nous constatons seulement une augmentation du nombre des plis et de leur hauteur. Il est aisé de comprendre la difficulté d'obtenir dans ce cas quelque variation sur la radiographie par la convergence des plis. Mais la variation, quant à la quantité, peut être très importante. — Si l'anastomose est située au point le plus bas de l'estomac, les plis, au lieu de se diriger comme d'habitude vers le pylore, continuent vers la nouvelle bouche (voir fig. 7); là, ils semblent parfois se confondre avec les plis de l'intestin. Si l'orifice est situé sur la paroi postérieure, les plis se groupent comme nous le voyons dans la fig. 6. Nous observons ici, combien le relief augmente à l'approche de l'anastomose. Au-delà de celle-ci nous ne voyons que peu de plis, relativement peu élevés. Si la gastro-entérostomie est placée près de la grande courbure, un peu en haut sur le corps de l'estomac, l'image aura l'apparence de la fig. 2 b; (comme point de comparaison, voir un estomac normal, fig. 2 a). Les plis de la fig. 2 b présentent une déviation nette dans la direction de l'anastomose, (comparez également la préparation sur l'image 3!). La différence entre ces trois derniers groupes est plus apparente que réelle, elle est plus accusée dans l'image radiographique que dans la réalité anatomique. Au point de vue radiologique, il nous est cependant permis de nous servir de ces groupes.

Il en est de même pour l'intestin grêle qui présente des images différentes de la normale au voisinage de la gastro-entéroanastomose. Les opinions sont loin de s'accorder pour l'interprétation de ces différences. GOETZE[1], par exemple, prétend que les plis de la muqueuse disparaissent souvent près du nouvel orifice; tandis que GÖCKE[2], au contraire, s'exprime ainsi: « an der gefüllten abführenden Jejunum-

[1] GOETZE, «Das Roentgenbild des operativ veränderten Verdauungstractus». — «Roentgendiagnostik in der inneren Medizin und der Grenzgebiete» de Franz Groedel (1921), page 692.

[2] GÖCKE, «Beiträge zur Morphologie des Magens nach Resektionen». — «Beiträge zur Klinischen Chirurgie». Vol. 99 (1916), page 366 et fig. 94.

schlünge die Kerkringschen Falten besonders deutlich hervortreten ». Je rappelle que dans la discussion citée plus haut sur l'ulcère peptique jéjunal,[1] Forssell et Ström se sont exprimés ainsi: Ström prétendait qu'on ne voie ordinairement aucun pli sur l'intestin à l'orifice de la gastro-entérostomie, tandis que Forssell dit que ces plis sont au contraire si nombreux et si rapprochés les uns des autres, que le lumen en est diminué et que la paroi en paraît être lisse, ce qui explique l'observation de Ström. Il est possible d'expliquer cette divergence d'opinion par des variations dans les différentes images de la muqueuse. Dans certains de mes cas, j'ai constaté que les plis de la muqueuse présentent une propension certaine à s'accumuler en plus grand nombre à l'anastomose. Les plis sont souvent remarquablement élevés, ils s'accumulent sur la paroi opposée à l'anastomose, affectant la forme d'une sorte de bouchon dont la pointe se dirige vers l'anastomose (voir fig. 13 b et 14). *Cette image n'est pourtant pas constante*, car au bout d'un moment, on voit que les plis diminuent, leur forme se modifie, et ils s'effacent parfois tout à fait.

Mon étude porte sur *35* cas examinés radiologiquement, plus cinq préparations anatomiques d'estomacs munis de gastro-entéroanastomoses. Je citerai ici 11 cas qui représentent le mieux les différents types d'altérations.

Groupe I. Estomacs avec gastro-entéroanastomose seulement

Cas I. Homme de 40 ans, opéré il y a dix mois pour un ulcère juxta-pylorique, la gastro-entéroanastomose fut placée « assez haut sur le corps de l'estomac ». Bien portant depuis.

Radiographié (fig. 2 b) suivant la méthode Rendich. La gastro-entéroanastomose se voit un peu en haut sur la grande courbure; les plis de l'estomac se dirigeant vers elle.

Cas II. Homme de 69 ans, opéré pour un cancer d'estomac inextirpable (de canalis). On pratiqua une gastro-entéroanastomose; aucun examen radiographique postérieur à l'opération. Le malade succombe un mois plus tard. La coupe anatomique (fig. 3) nous montre une déviation sensible des plis de la paroi postérieure dans la direction de la gastro-entéroanastomose (comparez fig. 2 b). Dans l'intestin grêle il existe une abondante agglomération de plis avoisinant la nouvelle bouche.

Cas III. Homme de 60 ans, opéré pour ulcère calleux du duodenum, bien portant. Nous l'examinons au bout de 15 mois (fig. 4): l'estomac se vide pour la plus grande partie par une anastomose

[1] *Acta Radiologica.* Vol. III, fasc. 2—3, page 222—225.

située au pôle inférieur de l'estomac. Autour de cette bouche, nous observons une agglomération marquée des plis de la muqueuse stomacale, convergeant vers la nouvelle bouche.

Cas IV. Homme de 30 ans, opéré il y a 4 ans pour un ulcère duodenal perforé. La gastro-entéroanastomose fut pratiquée. Examen radiographique: la gastro-entéroanastomose est assez haut placée, le calibre de l'estomac fortement retréci à la hauteur de l'anastomose. Sur la fig. 5 a, obtenue par la méthode RENDICH nous voyons que les plis longitudinaux sont traversés de plis obliques accentués, lesquels se dirigent vers la gastro-entérostomie. Sur l'image 5 b nous voyons ces plis obliques produire une «dentelure» claire des contours de l'estomac, au siège de l'anastomose. Enfin nous avons constaté sur l'intestin grêle une niche de la grosseur d'un pois (non visible sur la fig. 5 a). Notre diagnostic d'ulcère peptique jéjunal fut vérifié à l'opération.

Cas V. Homme de 38 ans, opéré pour un ulcère du duodenum ayant provoqué une sténose.

Gastro-entérostomie postérieure. Mort 3 semaines après. Sur la coupe anatomique (fig. 6) les plis de l'estomac se dirigent vers la gastro-entéroanastomose; leur relief est plus prononcé dans le voisinage de l'orifice; au-delà, on ne constate que quelques plis relativement peu prononcés.

Cas VI. Homme de 30 ans, opéré d'une gastro-entérostomie postérieure pour un ulcère duodénal. Le nouvel orifice est situé en bas de l'angle, près de la grande courbure. Depuis deux semaines le malade souffre de malaises diffus. Nous l'examinons 16 mois après l'opération (fig. 7). En décubitus dorsal et ventral, l'estomac se vide aussi bien par le pylore que par la nouvelle bouche; quoique lentement par cette dernière. En station debout « évacuation précipitée » à travers la gastro-entéroanastomose. Dans toutes les positions, nous constatons que les plis stomacaux du sinus[1] au lieu de se diriger vers le pylore, continuent jusqu'à l'anastomose. Sur la radiographie prise en position debout il semble même que quelques-uns de ces plis se poursuivent dans les plis de l'intestin.

Groupe II. Estomacs ayant subi et résection et gastro-entérostomie

Cas VII. Femme de 53 ans, ayant subi une résection de la plus grande partie de l'estomac pour un cancer du sinus, de plus une gastro-entérostomie termino-latérale. L'examen radiographique eut lieu 15 jours après l'opération (fig. 8 a et b). L'anastomose est

[1] J'emploie ici la nomenclature de FORSSELL (Arch. d'El. Méd. 1912, P. 529).

en partie remplie de plis d'estomac *variant en nombre et en forme.* L'orifice montre un calibre différent dans les deux images.

Cas VIII. Homme de 64 ans, opéré pour un cancer du canalis: résection et gastro-entérostomie termino-latérale. Il succombe 24 jours plus tard. La préparation anatomique (fig. 9) nous montre des plis assez nombreux convergeant vers l'anastomose. De même, dans l'intestin grêle, les plis augmentent et en nombre et en relief vers la nouvelle bouche. Cette augmentation est même si prononcée vis-à-vis l'orifice, qu'il semble s'élever un véritable bouchon muqueux contre cet orifice.

Cas IX. Femme de 31 ans, opérée pour un ulcère duodénal. Résection et gastro-entérostomie termino-latérale, à la suite de laquelle parurent de véritables symptômes d'ileus stomacal. Nous procédons trois semaines après à l'examen radiographique et constatons un groupe étoilé d'une quinzaine de plis, (fig. 10 a d'après la méthode Rendich, fig. 10 b d'après la méthode ordinaire et en exerçant une légère pression sur la gastro-entéroanastomose). Aucune évacuation stomacale ne se produit et la malade rejette ensuite le repas opaque. Le lendemain: réopération au cours de laquelle il fut impossible de découvrir le moindre obstacle au passage alimentaire, l'anastomose était perméable à deux doigts. On procéda cependant à une nouvelle gastro-entérostomie, antérieure cette fois-ci; mais la malade succomba au bout de 10 jours. Une heure après la mort, il fut fait une injection de formaline dans l'artère carotide. La préparation anatomique (fig. 11) nous montre sur la 1re gastro-entéroanastomose le même groupement étoilé, observé sur les radiogrammes, l'orifice est rempli de plis et ne permet aucun passage (g—e 1). A la gastro-entéroanastomose antérieure, les plis de l'anse grêle faisaient irruption dans le lumen de l'estomac (g—e 2).

A l'examen microscopique de la coupe transversale des plis de l'estomac (voir fig. 12 a et b), nous voyons que la musculaire-muqueuse est sensiblement plus étroite dans les sillons entre les plis (fig. 12 a), qu'au sommet de ces plis (fig. 12 b), parfois seulement moins large de moitié. Au fond des sillons, les cellules musculaires lisses ont à peu près la même direction que la coupe; et leurs noyaux out une forme allongée. Au sommet des plis, les cellules semblent être touchées seulement en partie dans leur direction de longueur, le plus souvent en biais ou en travers; ces cellules sont placées à une plus grande distance les unes des autres que dans les sillons et même les noyaux qui se dirigent dans la direction de la coupe sont plutôt courts. (Reuterwall).

Groupe III comprenant les cas présentant des altérations prononcées du relief muqueux de l'anse grêle à la gastro-entéroanastomose
(comparez aussi les cas II et VIII)

Cas X. Femme de 40 ans opérée d'une gastro-entérostomie il y a six ans, parce qu'on soupçonnait un ulcère. Bien portante depuis. Examen radiographique: Lorsque la malade est dans la position couchée (figure 13 a, méthode RENDICH), l'estomac se vide assez lentement à travers l'anastomose. Les plis intestinaux sont larges et peu nombreux. Dans la position debout, (voir les radiogrammes en série 13 b; les expositions sont faites à 1 minute d'intervalle) l'évacuation est plus rapide. L'image de l'intestin grêle présente une altération frappante, les plis sont plus nombreux et plus minces; à un endroit, en face de l'orifice de l'anastomose, ils sont groupés à côté l'un de l'autre, ce qui donne l'impression d'une assez grande lacune (s_1, s_2, s_3). *Cette lacune varie et comme grandeur et comme forme.* A la première exposition elle a sa plus grande étendue (s_1), et son contour supérieur présente trois saillies arrondies, prouvant l'existence d'au moins autant de plis; à la 2e et 3e exposition elle a diminué d'étendue, et à la 4e nous n'observons que deux plis peu élevés.

Cas XI. Homme de 63 ans, opéré d'une gastro-entérostomie antérieure pour un cancer inextirpable du canalis. Nous l'examinons cinq semaines après l'opération (voir fig. 14! Expositions à une minute d'intervalle). En position debout, on observe une altération nette du relief de la muqueuse de l'intestin, près de l'anastomose. A la première exposition (1) le lumen de l'intestin est, vis-à-vis de l'anastomose, rempli du repas opaque. Pas de plis élevés. Au bout d'une minute environ, nous voyons une lacune (s_1) se dessinant du contour vis-à-vis de l'anastomose, et l'atteignant presque. Cette lacune diminue ensuite (s_2) et a disparu à la 4e exposition.

Tous ces examens nous prouvent que la muqueuse gastro-intestinale a la faculté de varier son relief en s'adaptant à la nouvelle bouche.

Cette faculté n'est pas seulement une réaction passive post-opératoire, comme par exemple un plissage de la muqueuse par les sutures. Le relief typique de la muqueuse peut être observé plusieurs années après l'opération. Dans l'estomac, l'altération de la direction des différents plis, peut être observée assez loin dans l'organe. Surtout l'examen microscopique des préparations anatomiques, nous montre que les plis se forment, à la suite d'une activité de la muqueuse elle-même. FORSSELL dit[1] dans le travail cité plus haut:

[1] «Studies of the mechanism of movement etc.» Comparez aussi «Ueber die Beziehung der Röntgenbilder etc.», page 252 et 257.

« The movements of the mucus membrane produce an extremely differentiated distribution and restraining of the food in digestive chambers of varying form and size, and procure the fine regulation of the current by the passage of the contents in the alimentary canal. » *Si nous demandons d'autres effects à ce pouvoir régulateur, en créant par exemple un nouvel orifice dans le canal digestif, nous pouvons attendre que la muqueuse altère son relief en conséquence.* Mes observations prouvent qu'il en est ainsi. A l'appui de cette opinion je peux mentionner que dans les cas où l'anastomose n'a pas fonctionné j'ai pu constater, que la muqueuse ne présentait aucune des altérations relatées ci-dessus.

Il est possible aussi que nous nous trouvions en présence d'une sorte d'essai de la muqueuse tendant à combler la lacune produite par la gastro-entérostomie. Ce qui se passe dans l'intestin grêle corroborerait cette hypothèse; mais cela ne pourrait fournir qu'un remplissage partiel et temporaire de la nouvelle bouche. Le cas IX montre que ce remplissage peut être permanent et complet. Une forte diminution opérative du calibre pourrait peut-être prédisposer à cet état. Cette explication n'est cependant pas satisfaisante. Lorsque nous examinons macroscopiquement une préparation anatomique avec ses plis élevés, larges, convergents et ajoutons un examen microscopique, nous sommes forcés de penser à un état spastique local de la musculaire-muqueuse.

Mes observations sont insuffisantes pour juger sûrement la question; mais il me semble pouvoir avancer une hypothèse, qui peut-être, contribuera à expliquer les ileus stomacaux, consécutifs aux résections de l'estomac.

Dans les rapports publiés jusqu'ici, nous voyons que dans des cas pareils les résultats d'autopsie pratiquée d'après la méthode ordinaire ont été négatifs; car les reliefs de la muqueuse avaient déjà eu le temps de subir des altérations post-mortales, ils étaient parfois entièrement effacés, de façon à ce qu'il fût impossible de juger du rôle qu'ils avaient pu jouer dans la configuration de la bouche anastomatique.

Je citerai ici un cas, où, après un ileus stomacal, consécutif à l'opération, j'usai d'un procédé thérapeutique basé sur mon hypothèse.

Une femme de 44 ans souffre en 1917 et en 1920 de symptômes d'ulcère. En décembre 1924 elle est malade depuis 3 semaines, vomissements quotidiens. Le $^{30}/_{12}$ 1924 examen radiographique: nous posons le diagnostic d'ulcère pénétrant juxta-pylorique. Opérée le $^{5}/_{1}$ 1925, le diagnostic radiographique fut vérifié et reconnu exact.

On procéda à une résection des parties ante-pyloriques du canalis d'après la méthode BILLROTH I, plus gastrostomie.

4 à 5 jours plus tard il y eut des symptômes d'obstruction, qui augmentèrent d'intensité, si bien que le $^{12}/_{1}$ tout liquide ingéré par os ou par la fistule, était recueilli par cette dernière deux heures plus tard. Le $^{13}/_{1}$ à $1^{h}\,1/2$ on introduisit 200 cc de mélange lacté, à 2^{h} 100 cc et à $2^{h}\,1/2$ 200 cc du même mélange; à 3^{h} 10 il sortait de la fistule 400 cc. Aucun signe de péritonite. Le chirurgien pensait à intervenir de nouveau, mais l'état général de la malade était mauvais avec complication de bronchite. Après une consultation avec le Dr G. THORELL, comme nous pensions être en présence d'une altération comme celle décrite plus haut (voir cas IX 1), on fit à 3^{h} 15 une injection intra-veineuse de 0.02 gr. de papavérine. Immédiatement après 200 gr. de mélange lacté furent introduits dans l'estomac; à 4^{h} 15 l'estomac était vide et il ne paraissait au lavage aucune trace d'aliments. A 4^{h} 20 un nouveau repas de 200 gr. qui pénétra dans l'intestin dans l'espace d'une heure. Depuis lors le passage s'est fait sans le moindre obstacle.

L'état général de la malade s'améliora sensiblement dès quelques heures après l'injection.

Le rôle joué ici par la papavérine contre l'obstruction est indiscutable. Il est impossible de savoir l'endroit où son action s'exerça, l'état de la malade n'ayant malheureusement permis aucun examen radiographique pendant la période d'ileus. La faculté connue qu'a la papavérine de relâcher la musculature lisse écarte toute possibilité d'atonie primaire de l'estomac et du duodenum dans le cas qui nous occupe. Il n'y a pas non plus de raisons de supposer que l'obstacle ait été causé par une pression ou une traction des parties supérieures du canal digestif. Mais, étant donné l'effet produit par la papavérine, nous avons toutes raisons de supposer que l'obstacle fût causé par un état de contraction de la musculature lisse.

A cause du cas que je viens de décrire, le Dr THORELL a examiné l'action de la papavérine sur la musculature de la muqueuse d'un estomac de grenouille nouvellement disséquée et il a eu l'obligeance de me faire part du résultat. La fig. 15 montre deux des courbes obtenues. Il fut employé soit 0.5 % de chlorure de barium soit le courant faradique, dans le but de démontrer l'excitabilité de la musculature. Les courbes montrent clairement que, même à doses très faibles, la papavérine paralise la musculature de la muqueuse stomacale au point que le chlorure de barium, agent spécifique d'irritation de la musculature lisse, n'a aucune action sur elle.

Ces cas d'ileus stomacal indiquent la possibilité que le mécanisme de la muqueuse soit un facteur à considérer non seulement dans le

diagnostic radiographique mais encore dans l'appréciation clinique et la thérapie.

Explication des figures

g-e = gastro-entéroanastomose.
c = cardia.
can = canalis egestorius.
min = curvatura minor.
maj = curvatura major.
j = anse grêle.
col = colon.
corp = corpus ventriculi.
f = fornix ventriculi.
m = musculaire-muqueuse.

Explication des courbes (fig. 15)

Courbe I. En 7: excitation à 0.5 % de chlorure de barium, en 8 et 9: lavage à la solution de Ringer, en 10: chlor. de papavérine 0.005 %; 11: lavage à la sol. de Ringer. Au bout de 3 heures l'excitation au chl. de barium ne produit aucun effet.

Courbe II. Dans cet état l'organe n'est pas sensible aux poisons légers. 10 chl. de barium, 11 chl. de papavérine, 13 chl. de barium.

Courbe III. 9 chl. de barium, à 11 chl. de papavérine, ensuite ni l'excitation électrique (13) ni le chl. de barium (14) ne produisent d'effet.

Courbe IV. Elle nous montre comment une contraction se développe d'ordinaire, lorsqu'elle n'est influencée d'aucune manière.

RÉSUMÉ

L'auteur communique ses observations sur le relief de la muqueuse autour des gastro-entéroanastomoses. *Trente-cinq* malades chez qui on a pratiqué soit la résection avec gastro-entérostomie soit la gastro-entérostomie seule, ont été examinés aux rayons X. De plus cinq préparations anatomiques ont été étudiées. 11 de ces cas sont décrits en détail, et illustrés par des images radiologiques ou photographies des préparations. Les plis de la muqueuse de l'estomac et de l'anse grêle semblent, d'après les images, avoir subi un regroupement important aux alentours de l'anastomose. Dans l'estomac, les plis convergent vers l'anastomose et sont souvent plus rapprochés et plus élevés que ce que nous constatons au même endroit, dans les estomacs non opérés. Du côté de l'intestin grêle, les plis ont une tendance à s'agglomérer en plus grand nombre, autour de l'anastomose. Partant de l'avis de Forssell, que les plis de la muqueuse, par des mouvements actifs, se chargent de la fine régularisation du passage alimentaire, à travers le canal digestif, l'auteur avance l'hypothèse, que les reliefs des deux côtés de l'anastomose, démontrés ci-dessus, sont le résultat de mouvements actifs de la muqueuse. Il avance également, comme résultat possible, que d'après ses recherches il pourrait se produire, dans certains cas, un état spastique accentué de la musculaire-muqueuse, lequel pourrait entraver l'évacuation par la bouche anastomatique.

ZUSAMMENFASSUNG

Verf. berichtet über Beobachtungen betreffs der Schleimhautformationen in der Nachbarschaft von Gastroenteroanastomosen. Die Röntgenunter-

suchungen wurden an *35* Patienten vorgenommen, bei welchen Resektion mit Gastroenterostomie ausgeführt worden war. Ausserdem wurden 5 Sektionspräparate von derartigen Fallen studiert. 11 Fälle sind ausführlich beschrieben und mit Röntgen- resp. Präparatbildern illustriert. Die Schleimhautfalten des Magens und Dünndarms haben, wie aus den Bildern ersichtlich ist, in der Nähe der Anastomose eine wesentliche Umgruppierung erfahren. Im Magen konvergieren die Falten gegen die Anastomose und sind oft dichter gestellt sowie höher, als es sonst an den entsprechenden Stellen der Fall ist. Auf der Dünndarmseite weisen die Falten in der Nähe der Anastomose die Neigung auf, sich in reicherer Anzahl anzusammeln als in der Umgebung.

Ausgehend von FORSSELLS Ansicht, dass die Schleimhautfalten durch aktive Bewegungen die feinere Regulierung der Nahrungsbeförderung durch den Verdauungskanal besorgen, stellt Verf. die Hypothese auf, dass die nachgewiesenen Mukosfigurationen auf beiden Seiten der Anastomose durch aktive Schleimhautbewegungen zustandegekommen seien.

Verf. hebt auch hervor, dass in gewissen Fällen durch einen hochgradigen spastischen Zustand in der Muscularis mucosae vielleicht ein Hindernis für die Entleerung durch die Anastomose herbeigeführt werden mag, eine Annahme, die ihm durch seine Untersuchungen nahegelegt zu sein scheint.

SUMMARY

The writer gives an account of some observations of the mucuous membrane formations in the neighbourhood of gastroenteroanastomoses. Roentgen examinations have been made of *35* patients on whom resection with gastroenterostomy or only gastroenterostomy has been performed. In addition, 5 post-mortem specimens of such patients have been studied. Eleven cases are described in detail and illustrated with roentgenograms or drawings of the specimens respectively. In the pictures the folds of mucous membrane of the stomach and small intestine are seen to have been re-arranged to an essential degree in the neighbourhood of the anastomosis. The folds in the stomach converge towards the anastomosis, and are often lying closer together and are higher than they usually are at the corresponding place of a normal stomach. The folds on the intestinal side show a tendency to collect in greater numbers near the anastomosis than in its surroundings.

On the basis of FORSSELL's opinion that the folds of mucous membrane manage, by active movements, procure the fine regulation of the passage of food through the alimentary canal, the writer suggests the possibility that the demonstrated mucous membrane formations on either side of the anastomosis are produced by active movements of the mucous membrane.

The writer emphasizes further that his investigations may possibly justify the supposition that a high-grade spastic condition of the muscularis mucosae in certain cases can produce obstruction to the passage through the anastomosis.

FROM THE ORTHOPEDIC CLINIC OF THE CAROLINE INSTITUTE, STOCKHOLM
CHIEF: PROFESSOR PATRIK HAGLUND

A "FORME FRUSTE" OF CHONDRODYSTROPHIA WITH CHANGES SIMULATING SEVERAL OF THE KNOWN "LOCAL MALACIAS"

by

Nils Silfverskiöld, M. D.

(Tabulæ XVI—XVIII)

L.H.A., ♂, born 4.6.1912. No dwarfism in the family. No one of the family has any known signs of endocrinic disturbances, nor are there any deformities whatever. No known hereditary syphilis or tuberculosis. There are seven children in the family, all of whom are very healthy and robust, with the exception of one brother (aged twenty) who has lately been operated upon for sarcoma of the femur following a trauma. According to the information given by the mother of the patient, delivery was normal and at full term. Nothing abnormal was observed about the patient during the first months. He did, however, not develop like the other children, was delicate and fretful during his first years of life. His mother thinks she remembers that the legs of the boy looked "queer,, already when he was one year old. He was thought to have the rickets, and was treated with ointment cure, though no doctor, neither then nor later, was consulted until to-day. His mother is of the opinion that the legs and the essential features of the patient were acquiring their present appearance till about the fifth year and that it has remained about stationary since then. The patient could walk and had begun to speak at the age of one. Dentition took place at the right time. His general condition improved, and after the age of five it was just as good as that of the other children of the family. Since that time the patient has been able to run about and play just like other children. He is attending school, is intelligent, and has of late even skipped a class. The patient has had no pain or other troubles of insufficiency His mother has brought him to the clinic to hear if anything could be done about the deformities.

Status on 10.2.1923: General condition very good. Intelligence good. Figs. 1—3 show the patient and his healthy, two years younger brother. In comparing the two, one finds that the upper extremities and the trunk are well developed, and may be said to be fairly normal for the age of the patient. His upper arms, however, are slightly shorter and his forearms longer than the brother's. Height 124 centimeters. Weight 30 kilos. His head is remarkably large, vault of a "square" type. Its circumference 53.5 centimeters. Biparietal diameter 16 centimeters. The cartilaginous part of

the nose is depressed, and there is deficient development of the cartilaginous bridge, whereas the bony part of the nose shows but a slight depression. Teeth normal. Clinically, his bearing and gait corresponds very closely to what is seen in bilateral luxation of the hip-joint, with marked lumbar lordosis and high-grade inclination of the pelvis. Trochanteric regions are prominent; femora slightly curved in S-shape, short (as compared with other parts of the extremities, as well as with those of his brother). The knee regions are thickened; moderate genua valga. Calves are somewhat thin; musculature of thighs also shows some atrophy. The feet have a slight tendency to varus position, are shorter than the feet of his brother, and

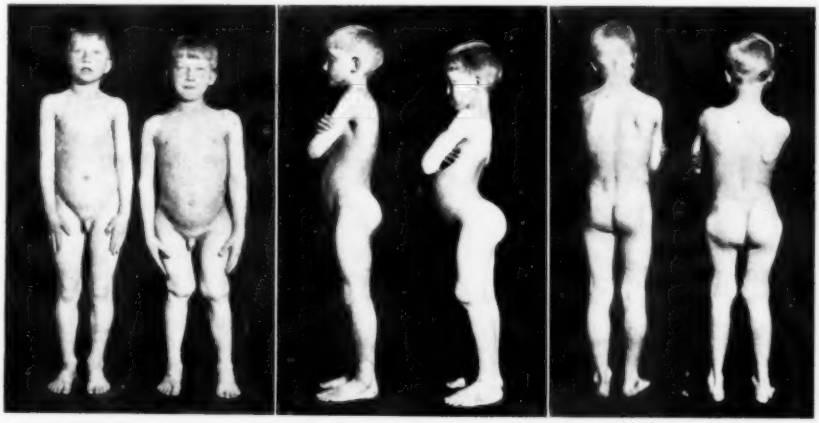

Fig. 1. Fig. 2. Fig. 3.

somewhat clumsy, especially in tarsus and metatarsus. Arches of the feet are slightly higher than those of his brother. The regions of the metatarsophalangeal joints of the great toes are thickened, mostly in the right foot.

Hip-joints: *Left hip* can only be extended to 135°, from which position it can be flexed to an angle of 70°. Half adduction possible. Slight abduction. Hardly one third of normal rotation. *Right hip* can only be extended to 150°; flexion is but slightly reduced; adduction normal; abduction greatly reduced. About one half of normal rotation. The habitual position of rotation of both thighs corresponds to the normal position.

Throchanter major is felt to be clumsy and considerably enlarged in both legs, lying distinctly above the ROSER-NÉLATON line. TRENDELENBURG is *negative*.

The knee region in both legs is very thickened without any swelling, the thickening being very hard, and limited to the region of the joint itself. Extension and flexion normal, without any signs of crepitation. Outward rotation normal with knee bent, inward rotation almost absent. Both legs show habitual position of outward rotation of moderate degree, also with knees stretched.

Feet are of normal mobility. Only in the metatarsophalangeal joints of the great toes is the mobility slightly reduced.

The *lumbar lordosis* is not fixed, but disappears entirely in sitting posture. It corresponds, at least for its most part, to the flexion contractures of the hig-joints.

There is no materially thickened epiphysis in any other locations than those mentioned. No reduced mobility or such like. No rachitic rosary. No deformity of the thorax.

No clinical signs of syphilis, rachitis, or of endocrinic disturbances: thyroid gland of normal size; skin and growth of hair normal; no pressure-tenderness or other painfulness anywhere.

WASSERMANN test of the blood negative. *Reflexes* normal.

Roentgen Findings

Regions of the hip-joints (Fig. 4): acetabular cavities of the right and left side are on the whole of identical appearance. The bone substance in the immediate neighbourhood of the acetabular cavity is reduced to a great extent, the acetabulum in the roentgenogram appearing enlarged in upward, downward, and also inward directions. The line of demarcation between bone and cartilage forms a slight curve extending over an area of 6.5 centimeters length and about 2 centimeters depth, enclosing concentrically the site of the original acetabular cavity. The bony portion of the acetabulum has no well-marked line of demarcation toward the surrounding, greatly rarefied bone. This area of bone rarefaction is bounded above by curved contours, and below it stretches about half way down the rami sup oss. pub. et ischii. Within this area of rarefaction one can also discern other areas of higher rarefaction, partly of a rounded and partly of a streaked appearance.

The *upper ends of the femora* are deformed in a high degree. Of the *osseous nucleus of the head* there is only a thin laminar remainder, blending with the neck. The femoral neck has an almost horizontal, upper border, slightly inclined towards the medial side. The neck and the diaphysis show a distinctly increased width and clumsy shape, in addition to which there is a marked coxa vara. Towards the centre is seen an area of greater density, but otherwise the bone substance is spotted throughout with large rounded areas of rarefaction, from the size of a bean to that of a hemp-seed, which reach the surface in the region of trochanter major and at the upper border of the neck, and there produce depressions in the contour. The cartilaginous part of the head is seen to project lateral to the acetabular cavity. The inferior border of the neck is about two centimeters above SHENTON's line.

The *shafts of the femora* form a slightly S-shaped curve, but are on the whole of normal appearance.

The *lower ends of the femora* (Figs. 5—8) present, like the upper ones, a clumsy shape and increased width. The *epiphyseal line* is somewhat wavy, but not increased in height. No osteoid zones. The preparatory zone of ossification is normal. The *epiphysis of the femur* is very much broader than normal, and shows extremely incomplete calcification. The calcified area is immediately adjacent to the epiphyseal line, dorsally and laterally consisting only of a thin lamina. The calcified area is practically of the same appearance in the left as in the right knee, ending below with a

marked fringe, and showing a number of free osseous nuclei varying in size from a hazelnut to a hemp-seed. The bone marking resembles that of the femoral neck for instance. Within the *upper tibial epiphysis* the ossified area is somewhat irregular in form, but is sharply outlined. The bone marking is here somewhat streaked, and thinner than normal. *Tibial apophyseal nucleus* is still absent. *Patellae:* Bone marking finely porous. The apex is separated by a non-calciferous band. This separate bone shadow is of irregular form and about the size of a grain of rice.

Foot regions (Figs. 9 and 10):

The different bones are smaller than normal, especially in tarsus and metatarsus. *Tarsus:* Astragalus is smaller; especially the trochlea and head are considerably flattened. The apophyseal line towards the posterior process is markedly notched and irregular (is not seen in any of the roentgenograms reproduced). *Calcaneum* also is to an essential degree smaller than normal and of irregular shape. The whole of the posterior contour of the body is markedly wavy, as are also the apophyseal line and the nucleus of the apophysis. *Scaphoid:* the entire nucleus is considerably smaller and flatter than normal. Close to the upper medial part of the right scaphoid, and slightly proximal, there is a free, flat, and irregularly shaped osseous nucleus, the size of a small coffee-bean. *Cuboid*, too, has a noticeably small bony nucleus of irregular shape. The *external cuneiform* has a smaller nucleus than normal and is of angular shape. The four outer *metatarsals* are placed slightly in a position of supination. The *first metatarsal* shows abnormal conditions in several respects. It is shorter and clumsier than normal, and shows, in addition to the proximal epiphysis, also an abnormal distal "epiphysis" (See below, under "The hands"). The proximal epiphysis is of the same somewhat irregular and flat shape as was mentioned with regard to the various tarsal bones. The distal "epiphysis" also is markedly flat. The nucleus is divided into irregular portions, where areas deficient in lime and apparently non-calciferous areas are alternating with areas of greater density. Some nuclei within the "epiphysis" seem to be free. The somewhat clumsy basal phalanx of the great toe, too, has a distal epiphysis. The proximal epiphysis of the basal phalanx of the great toe is flattened, and shows changes of the same kind as seen in the distal epiphysis of the first metatarsal, though not so pronounced.

The *shoulder-joint regions* (Fig. 11):

The glenoid cavity as well as the upper end of humerus present conditions which deviate from the normal. The glenoid cavity has porous bone marking, and its bony surface, especially in its upper part, is indistinct and rough in outline. The osseous nucleus of the upper epiphysis of humerus is flatter and broader than normal. The epiphyseal line is irregular and the most adjacent region of the neck of the humerus shows a bone marking in which areas rich in calcium alternate with areas poor in calcium, and which therefore in this respect reminds, inter alia, of the conditions prevailing in the hip, though being less pronounced here. The bone marking of the upper part of the humeral diaphysis presents a streaked appearance.

The *elbow-joint regions* (Fig. 12): Signs of similar changes are seen here too, and manifest themselves particularly in the capitulum humeri, the osseous nucleus of which shows irregular marking, with notched distal contour. Medially, at the border of the trochlea, there is a smaller, free nucleus with indistinct marking.

The *hands* (Figs. 13 and 14): The lower epiphysis of the forearm seem to present but slight radiologic changes. *Carpus*, on the contrary, is abnormal in the same respects as tarsus. Its various bone nuclei are abnormally small for the age of eleven, especially those of the radial bones. While the changes in other parts of the extremities seem to be practically symmetrical, they are not so in the hand. The bony nucleus of trapezium of the right hand is the size of a coffee-bean, and that of the left hand is no larger than a grain of rice. The nucleus of the semilunar bone of both hands is certainly distinctly, though very slightly, smaller than normal. In the carpus of the right as well as of the left hand there are some few *free osseous nuclei*, the size of a grain of rice or smaller; grouped mainly around the scaphoid in the left hand, and around the unciform in the right hand. Both metacarpals and phalanges are a little shorter but not broader than normal. Extra epiphyses are seen in the proximal part of the second metatarsal, and in the distal part of the first metatarsal and basal phalanx of the thumb.

The *shoulder-girdle:* The conditions here do not deviate from the normal, or, at any rate, not distinctly or to any degree worth mentioning.

Vertebral column: The bodies of several vertebrae are narrower than normal, broader in front than behind.

The *cranium* presents a great shortening of the os tribasilaris, especially its anterior part, and increased declivity of the clivus. The anterior and middle fossae of the skull are considerably shortened, both absolutely and relatively, in the sagittal direction, while the posterior fossa is unusually extended. The root of the nose is a little depressed.

Here we have a peculiar case with several osseous changes, especially in the extremities, most pronounced in the lower ones. There are skeletal anomalies such as epiphyseal formations in foot and hand, which normally do not exist (first metatarsal, first and second metacarpals, basal phalanges of thumb and great toe), as well as free, extra osseous nuclei in carpus, tarsus, and other locations. Stunted growth is betokened above all by the osseous nuclei in tarsus and carpus; though this stuntedness varies in the different bones. Reduced weight-bearing ability is indicated by the changes in the hip-joints (the upward enlargement of the acetabular cavities, the compressed portions of the head, neck, and metaphyses of the femur), the slightly S-shaped femora, genua valga, the flattening of several bones of the foot, especially those subjected to the greatest pressure: astragalus (trochlea and head), scaphoid, cuneiform (first and second), the epiphyseal parts of the first metatarsophalangeal joint. In the shoulder-joint, too, the epiphysis is flattened, and slightly reduced in the capitulum humeri as well.

That this is a case of a so-called systemic disease of the skeleton is, I think, certain. Pathological changes in other organs could not be diagnosed. A specialist in endocrinic disturbances (Professor ISRAEL HOLMGREN) has not found any clinical signs of endocrinic

disturbances in other organs than the skeletal system, and is of the opinion that this case cannot be classed among the known endocrinic diseases. That the clinical picture presented by the patient is very rare, is a fact. On the other hand, however, it is also a fact which we cannot get away from that this is not a unique case; cases resembling this, at least in some of their changes, have previously been reported, inter alia under the diagnosis chondrodystrophia, (FRANGENHEIM, P. LEWIN and J. JENKINSON, and others).

The present case, however, shows several peculiarities that occasions me to publish it. What seems to me of especial interest is:

I. Whether and with which degree of probability a definite diagnosis can be made here?

II. Its relation to the so-called epiphyseal diseases, LEGG-CALVÉ-PERTHES-WALDENSTRÖM, KÖHLER'S etc.

I. Diagnosis

Firstly, as for the *diagnosis*, one must bear in mind that most of the systemic diseases of the skeleton are entirely unknown as to their aetiology. The diagnosis of most of them is therefore only symptomatologic. Certain clinical, histological, and roentgenological symptoms are considered characteristic of the various diseases; if all or most of these symptoms are present, there is more or less probability of the diagnosis being certain. On the other hand it follows as a matter of course that a purely symptomatologic determination of the nature of a disease will in many instances be only a vague diagnosis of probability. The literature on the so-called skeletal diseases bears more than enough evidence of this; think for instance of the most common group of these diseases, rachitis (rachitis tarda and inveterata) and osteomalacia. Most difficult is, naturally, the diagnosis in "formes frustes" and when the clinical picture seems to be due to a combination of two or more skeletal diseases.

After having followed the case in question for two years, with repeated examinations, and consulted several specialists (inter alia, Dr. E. LOOSER of Zürich; Professors G. FORSSELL, P. HAGLUND, I. HOLMGREN, and Dr. Å. ÅKERLUND, of Stockholm, to all of whom I beg to express my best thanks), I have come to the conclusion that the present case is probably to be regarded as an unusual form of *chondrodystrophia* (achondroplasia), a "forme fruste". To account for this view of mine I am giving the following tabular summary, the left column of which contains the clinical and roentgenological

symptoms[1] described as characteristic of chondrodystrophia at the age of twelve, while in the right column is stated the presence or absence of these symptoms in the case in question.

Chondrodystrophia	*Present case*
1. Disproportional dwarfism with noticeably short extremities, especially proximally ("micromélie rhizomélique").	Disproportional dwarfism; length of body distinctly stunted, though not in a high degree (Total height 124 cm.). Legs noticeably short; upper arms slightly shorter than normal; forearms and hands of a length not below normal (slight degree of "micromélie rhizomélique").
2. Large head.	Head, especially its width, larger than normal.
3. Often depression of root of nose.	Entire nose somewhat flattened, root of nose slightly depressed.
4. Noticeably short and broad, square or triangular hands ("main en trident").	Shape of hands is not differing from the normal.
5. Chest is often broader.	Fairly broad chest.
6. Widened ends of the bones of hip, knee, shoulder, and elbow joints.	Widened ends of the bones of hip and knee joints; signs of widening in shoulder and elbow joints.
7. Often widening of muscular insertions, especially the great trochanter.	Trochanters noticeably large, muscular insertions otherwise normal.
8. Often marked lordosis.	Marked lordosis (largely due to flexion contractures in the hips).
9. Head of fibula often reaches too high.	Head of fibula does not reach too high.
10. Often genua valga, sometimes genua vara.	Genua valga.
11. As a rule coxa vara.	Decided coxa vara.
12. Powerful musculature; joints sometimes looser than normal.	Powerful musculature; joints not looser than normal.
13. Sometimes small changes in vertebrae and pelvis.	Small pelvic changes, no marked vertebral changes (Cf Status).

[1] Histological examination has not been done.

14. Sometimes heredity.	No heredity.
15. Intelligence normal, or above normal.	Intelligence normal, or above normal.
16. Slow increase in length.	Slow increase in length.

Roentgen Examination

17. Os tribasilaris shortened, clivus steeper than normal.	Os tribasilaris shortened, clivus steeper than normal.
18. Irregular line of ossification; very irregular ossification of epiphyses of long bones; disturbed enchondral ossification.	Irregular line of ossification; very irregular and unusual ossification, especially of upper and lower epiphyses of femur; disturbed enchondral ossification, especially in lower extremities.
19. Undisturbed periosteal and endosteal ossification.	Undisturbed periosteal and endosteal ossification.
20. Increased width of epiphyses and metaphyses of long bones, the former being often held as in a cup by the latter.	Increased width of epiphyses and metaphyses of femora especially, but traceable also in those of the legs and arms, the epiphyses being nowhere held as in a cup by the metaphyses.
21. The fusion of the different epiphyses with their diaphyses shows no regularity, neither from one case to another, or in the same case.	The fusion between the different epiphyses and diaphyses shows no general regularity.
22. Metacarpals and the phalanges of the fingers are most often short and relatively broad.	Metacarpals and phalanges of the fingers are neither short nor relatively broad.
23. Carpus shows more or less high-grade retardation of growth of the nuclei of the radial bones, none or slight in the ulnar.	Nuclei of radial bones in carpus are small for the patient's age, those of the ulnar bones being about normal.
24. Osseous nuclei of tarsus are smaller than normal, distinctly angular.	Osseous nuclei of tarsus are smaller than normal, distinctly angular.
25. Sometimes extra epiphyses	1st metacarpal, 1st and 2nd

	in metatarsus and metacarpus.	metacarpals show extra epiphyses.
26.	Osseous nuclei of the epiphyses and metaphyses of the long bones show irregularly decreased density; porous, so that one believes they are soft.	Osseous nuclei of the long bones, especially of the femoral epiphyses and metaphyses but also elsewhere, show porous bone marking with reduced density. Islands of non-calcified tissue, or poor in calcium, are interposed between areas richer in calcium.

From the above table it is seen that the case in question tallies fairly well in most respects with the picture which various writers have described as characteristic of a chondrodystropic at the age of twelve. Whether the disease is congenital, is not quite obvious from the clinical history of the case, though this possibility is at any rate not contradicted by it. Especially the roentgenological symptoms are in all essentials characteristic of a chondrodystropic. The reason why these are nevertheless astonishing is that chondrodystrophics are relatively rare (we have, however, seen eight positive cases at the clinic in the last four years, seven of them being adults), and still more seldom come to be roentgen examined just at this age. Especially the following symptoms differ from the usual picture:

1. The disproportionate dwarfism is but relatively little marked.

2. The extremities show but slight degree of micromelia. According to JAROSCHY, however, there are cases with extremities of almost normal length.

3. The hands do not display even a trace of isodactylia. To this must be remarked, however, that a characteristic of the chondrodystrophia is that the symptoms are most strongly pronounced in the femora, and most slightly in forearms and hands. The same thing ought to be true in "formes frustes", and agrees also with this case.

4. In nearly all cases the head of the fibula reaches higher than normal. Reduced extension in the elbow-joint is an occurrence almost equally common. These symptoms are absent.

5. The ossification of the lower epiphysis of the femur. This does not seem to originate from a special epiphyseal nucleus, but from the epiphyseal disc. Note (in Figs. 5 and 6) the wide contact with the epiphyseal disc of the ossified portion of the epiphysis, the distal end of which portion is fringed.

6. A further number of osseous nuclei show some features which

differ from what has previously been described in cases of chondrodystrophia (Cf. below).

From a *differential-diagnostic point of view* one has to consider rachitis, the "local malacias", and possibly also syphilis, and (on account of certain roentgenological findings) "myxoedème fruste".

According to the statement made by his mother the patient had rachitis when a child. There are, however, no real facts to support this supposition of the mother, partly because no medical attendant was consulted, and partly because it is, as we know, usual for people to throw the blame on rachitis for all kinds of changes in the skeletal system, etc. Against his having had rachitis (in that case it would have been *rachitis inveterata*) argues, inter alia, the absence of any general bone atrophy worth mentioning, the absence of remission lines, a non-pathological height of the epiphyseal discs, and the nature of the preparatory zones of calcification. On the other hand, however, the possibility can very likely *not be precluded with certainty* that rachitis may have existed and may as a forma inveterata, still be complicating the clinical picture. The infantile, systemic diseases of the skeleton are, as far as their differential diagnosis is concerned, too vague to allow that preclusion. In this connexion it deserves being mentioned that (according to JAROSCHY) MARFAN and other French writers are of the opinion that achondroplasia and rachitis are nearly always associated. Rachitis can have a pathogenetic influence on the following symptoms among others: genua valga, the slightly S-shaped deformities of the femoral shafts, a materially increased width of the upper and lower ends of the femora, a certain degree of bone atrophy in certain circumscribed areas, delayed development of some osseous nuclei, square head, and shortening of the lower extremities, while the other parts of the body are of normal length, which, as we know, is considered to be characteristic of the rachitic dwarfism.

Nor can syphilis very likely be regarded as an aetiological factor. — The bone changes do not tally with those in hereditary syphilis; there is no periostitis; there are no signs of HUTCHINSON's triad, nor of any other changes specific of syphilis; and the WASSERMANN test of the blood is negative.

See below with regard to the relation of this case to "myxœdème fruste".

Closely associated with the question about "formes frustes" of chondrodystrophia is the question of *partial* or *localized chondrodystrophia*. According to JAROSCHY, SIEGERT has observed a case which seems to prove that chondrodystrophia can occur localized exclusively to one half of the body. According to NATHANSON, BUDDE

has described a similar case, and BUDDE himself published two cases in 1922, which he, stating his full reasons, considers "forma tarda" of localized chondrodystrophia.

II. Differential Diagnosis from the So-Called Local Malacias

The clinical pictures which sometimes appear in limited areas of the spongious tissue of the extremities, especially during the growing age, and which W. MÜLLER lately has comprehensively termed "local malacias", are chiefly as follows:

LEGG-CALVÉ-PERTHES-WALDENSTRÖM's change in the hip, SVEN JOHANSSON-SINDING LARSEN's in the apex of patella, OSGOOD-SCHLATTER's in the tubercle of the tibia, HAGLUND's in the calcaneal apophysis, KÖHLER's (I) in the scaphoid of the foot, KÖHLER's (II) in the heads of second and third metatarsals, KIEMBÖCK's in the semilunar bone, and further some so-called apophysites.

Since the present case, to a greater extent than any other case hitherto published (as far as I know), *shows roentgenologic findings which in several respects remind of most of these so-called local malacias*, I will here discuss the differential diagnosis between them and my case. The view has steadily been taken up more universally that the so-called local malacias are pathogenetically interrelated, being manifestations of one and the same "systemic disease". On the other hand, however, it is less certain whether their radiographic signs are of a very special type, as inter alia PLATT contends. That the roentgenologic symptoms with their many different locations in the present case are due to a common cause may, however, be supposed with a fair amount of probability.

1. LEGG-CALVÉ-PERTHES-WALDERSTRÖM's change is characterized (in roentgenograms) among other things by the following findings: The *epiphysis* is flatter and broader, the osseous nucleus fragmented; the fragments throw shadows of increased density, and often show an amorphous marking, whereas the areas between them are rarefied; in high-grade cases the nucleus may disappear entirely. The epiphyseal disc is often rarefied and of an irregular appearance. The *neck* and metaphysis often show, especially in high-grade cases, increased width, shortening, and coxa vara; are not unfrequently opaque and of an appearance reminding of what is found in the nucleus of the head (slightly irregular marking, with areas of reduced density alternating with areas of increased density); and may sometimes show small osseous deposits at the upper border of the neck. The *acetabulum* shows as a rule an irregular outline and a

marking reminding of that of the epiphyseal nucleus; the acetabular cavity in high-grade cases does not grasp the lateral portion of the head, whereby a certain degree of subluxation is produced. — If the above description is compared with Fig. 4, we will above all find a noticeable likeness, but also certain differences. These latter are, firstly, that the changes in this case are of a higher degree than in the cases hitherto published by LEGG-CALVÉ-PERTHES-WALDENSTRÖM, and, secondly, that the increased width of the upper end of the femur reaches beyond the intertrochanteric and the immediately subjacent regions which, in the same manner as the bone immediately surrounding the acetabular cavity, show a porous marking. — Extension, abduction, and rotation are limited as in the L.-C.-P.-W. cases, though to a greater extent. In summing up I would say that *the changes mentioned are above all more marked and extensive than those in the L.-C.-P.-W. cases.*

2. SVEN JOHANSSON-SINDING LARSEN's change in the patellar apex. Some few cases have been described, in which there is a fragmentation of the patellar apex, similar to the one in the clinical picture described by OSGOOD-SCHLATTER. The only roentgenologic finding in some of these cases is a small triangular fragment at the apex of patella. Figs. 7 and 8 show similar conditions.

3. OSGOOD-SCHLATTER's change. In this case there is no ossification of the tibial apophysis as yet.

4. HAGLUND's change in the calcaneal apophysis. The roentgenogram shows an irregular or, as it were, jagged apophyseal line; the osseous nucleus of the apophysis is fragmented, areas of increased density alternating with areas of reduced density. In this connexion it should perhaps be mentioned that ÅKERLUND, in "Archiv und Atlas der normalen und pathologischen Anatomie", 1918, published roentgenograms of healthy children having the most decided "apophysitis calcanei". The same condition is seen in Fig. 9 of the present case.

5. KÖHLER's change (I) in the *scaphoid bone of the foot* shows, on roentgenologic study, a distinct, sometimes high-grade flattening of the osseous nucleus which is rarefied and sometimes fragmented. — Figs. 9 and 10 reveal a distinct, although not a high-grade flattening of the nucleus, possibly a slightly increased density of the shadow, and two nuclei (which now, two years later, have become fused).

6. KÖHLER's change (II) in the second and third metatarsals. The metatarsal bones are often thickened in their entirety; their distal articular ends flat, broader, and of irregular outline; epiphyseal nucleus often fragmented (in the roentgenogram). — Figs. 9 and

10 show practically similar conditions in the *first* metatarsal: the whole bone is thicker and shorter than normal; the osseous nucleus of its distal (extra) epiphysis is flat, increased in width, and fragmented. The nucleus of the proximal epiphysis of the basal phalanx is of a similar appearance.

KIENBÖCK's malacia of the semilunar bone belongs, of course, to a considerably higher age than that of the patient in question; nor is there any corresponding change in this case.

As has been stated above, this patient presents further some other local changes, the appearance of which reminds very much of the above-mentioned "local malacias", in the head of the humerus for instance, the apophyseal nucleus of the internal epicondyle of the humerus, the changes in the capitulum humeri that resemble the clinical picture described by KAPPIS, and others. The fact of there being no local swelling, pain, or such like, in this case has nothing to do with the roentgenologic differential diagnosis; and, besides, it is well known that LEGG-CALVÉ-PERTHES-WALDENSTRÖM's change in the hip, and KÖHLER's change in the scaphoid, etc., not unfrequently have been diagnosed without there having been any clinical symptoms, at all events no pain or swelling.

If we now look at the local changes present in this case which have just been described, and compare them with the "local malacias", then I think we must admit that the resemblance, if not absolute, is nevertheless striking to a large extent. This case therefore, is undoubtedly calculated to illustrate the fact that the roentgenologic findings of the "local malacias" are not so specific as one previously has been apt to believe, but indicate a probably undeniable relationship with roentgenologic findings in other systemic diseases, here probably chondrodystrophia.

In the paper "Malum deformans coxae infantile" by the Danish physician P. FLEMMING MÖLLER, which was published in 1924, there is one case of a cretinoid dwarf aged forty-five which attracts notice. This case presents several similarities to the case reported above by me, and further it shows multiple bone changes of a nature related to the "local malacias" (W. MÜLLER) on which changes the administration of thyroid had a partially favourable effect.

With regard to FLEMMING MÖLLER's case and the question of "myxoedème fruste" in relation to the case reported by me, I find that a thyroid therapy ought to be tried in my case too, in spite of there being no clinical signs of myxoedema. It ought to be possible to judge an eventual effect of this treatment, all the more as I have followed the case for two years without any treatment.

The condition of the patient is now, January 1925, but little changed. His height has increased by 4 centimeters. The osseous nuclei have grown and several of the changes in the bone marking have become partially organized.

SUMMARY. The writer describes a *peculiar case of chondrodystrophia*, in which the forearms and hands are in all essentials of normal development. Besides, this case presents, to a greater extent than any other case hitherto published, roentgenologic changes which in many respects remind of the roentgenologic findings in LEGG-CALVÉ-PERTHES-WALDENSTRÖM's disease of the hip, KÖHLER's disease of the scaphoid, and the other so-called "local malacias".

ZUSAMMENFASSUNG. Verfasser schildert einen *eigentümlichen Fall von Chondrodystrophie* mit im wesentlichen normal entwickelten Vorderarmen und Händen. Der Fall zeigt ausserdem, in grösserem Ausmass als irgendeiner von den bisher publizierten, Röntgenbilder, die in vielen an LEGG-CALVÉ-PERTHES-WALDENSTRÖMS Krankheitsbild in der Hüfte, KÖHLERS Navikularkrankheit und die anderen sog. «Lokalen Malazien» erinnern.

RÉSUMÉ. L'auteur décrit *un cas étrange de chondrodystrophie* avec développement sensiblement normal des avant-bras et des mains. Ce cas fournit en outre, dans une mesure plus large que les cas antérieurement publiés, des images radiographiques qui rappellent, par bien des points, le tableau nosologique de LEGG-CALVÉ-PERTHES-WALDENSTRÖM au niveau de la hanche, la maladie naviculaire de KÖHLER et les autres affections dites «malacies locales».

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ROENTGENUNTERSUCHUNG DER LUNGE NACH INJEKTION VON LIPIODOL IN DIE BRONCHIEN

von

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(Tabulæ XIX—XX)

Im dritten Bande dieser Zeitschrift (S. 157) berichteten Danielsson und Manfred über ihre Erfahrungen mit der von Sicard und Forestier zuerst angegebenen Methode um mittels Einspritzung von Lipiodol in die Luftwege mehr Klarheit zu bringen in die manchmal unentwirrbaren Roentgenbilder des Thorax. Sie betonen dabei, dass diese neue Methode für die Diagnostik der Lungenkrankheiten von Nutzen sein könne. An einigen Beispielen möchte ich nun zeigen, wie glänzend die Resultate dieser Lipiodoluntersuchung sind.

Da wir bei unseren Patienten fast dieselbe Technik anwendeten wie von Danielsson und Manfred beschrieben, erübrigt es sich, diese nochmals ausführlich mitzuteilen. Ich möchte aber raten, nicht nur den Larynx mitsamt dem Kehldeckel zu cocainisieren, sondern auch die Glottis anaesthetisch zu machen, um mittels einer gebogenen Kanüle das Oel gleich in die Trachea hineinspritzen zu können. Um während der Einspritzung Hustenanfälle vorzubeugen, haben wir immer zuerst etwa 2 c. M.^{3} einer 5-prozentigen Cocainlösung in die Trachea eingeführt. Störenden Husten während der Untersuchung haben wir durch diese Massnahme nicht erlebt.

Bis jetzt haben wir hauptsächlich die Lipiodolfüllung zu Hilfe gerufen, um im Zweifelsfalle die klinische Diagnose Bronchiectasien zu erhärten oder auszuschalten. Haben wir zu tun mit klinisch deutlichen Fällen, dann kann das Lipiodolbild uns manchmal wichtige Anhaltspunkte geben für einen eventuell einzuleitenen chirurgischen Eingriff, da es genau Auskunft gibt über Grösse, Form und Lage der einzelnen Hohlräume. Viel wichtiger scheint es mir aber, in den Fällen eine Untersuchung mittels Lipiodol einzuleiten, wo mit den gewöhnlichen klinischen Mitteln die Sachlage nicht ganz klar wird. Über zwei Fälle dieser Kategorie möchte ich etwas ausführlicher berichten.

Fall 1. Frau P. 29 Jahr. Im März 1924 normale Entbindung. Während der Schwangerschaft, Ende 1923, einige Zeit Blasenbeschwerden, dabei Oedeme der Augenlider und der unteren Extremitäten. Diese Beschwerden schwanden, nachdem der Patientin eine Milchdiät verordnet war. Zwei Tage nach der Entbindung Brustschmerzen rechts mit Husten und Kurzatmigkeit. Sie hatte Auswurf, dieser war ab und zu blutig tingiert. Vierzehn Tage später auch links Brustschmerzen. Bei der Spitalaufnahme am 3. Juli ergibt die Lungenuntersuchung vorne nichts Abnormes. Hinten unten links ist der Percussionston etwas kürzer als rechts. Rechts und links hinten unten vereinzelte feuchte sehr kleinblasige Rasselgeräusche. Das Sputum ist schleimigeitrig, nicht übelriechend, enthält keine Tuberkelbazillen, wohl aber elastische Fasern; das tägliche Quantum ist etwa 100 c. M.^{3} Die Roentgenuntersuchung ergibt nur eine etwas geringere Beweglichkeit der linken Diaphragmahälfte. Der Urin enthält 5 ‰ Eiweiss. Nach zwei Monaten Klinikaufenthalt ist der Zustand fast unverändert. Im Urin immer 5 ‰ Eiweiss. Die Sputummenge wechselt zwischen 80 und 120 c. M.^{3} Bei der Auscultation sind nur noch spärliche Rasselgeräusche zu hören. Roentgenbild keine Veränderung.

Der objective Lungenbefund rechtfertigt also nicht die Diagnose Bronchiectasenbildung, obwohl die grosse Sputummenge Verdacht erregen muss. Zur Klärung des Krankheitsbildes wird zuerst rechts und zwei Wochen später links 20 c. M.^{3} Lipiodol eingeführt. Rechts werden nun zwei Hohlräume sichtbar, welche ungefähr einmarkstück gross sind (Fig. 1). Die Lage unterhalb der Diaphragmakuppel erklärt auch, dass das gewöhnliche Roentgenbild die richtigen Verhältnisse nicht aufdeckte. An der linken Seite war keine deutliche Höhlenbildung, wohl aber eine diffuse Erweiterung einzelner Bronchien. Da der Zustand stationär bleibt und die Eiterung aller Wahrscheinlichkeit nach die kranken Nieren noch mehr schädigt, wird versucht mittels Rippenresektion die beiden Hohlräume zusammenfallen zu lassen. Nach der Operation fühlt sich Patientin viel gebessert, das Quantum Sputum hat abgenommen bis etwa 40 c. M.^{3} täglich.

Der zweite Fall, den ich aus unserem Material herausheben möchte, ist folgender.

Fall 2. B. 22 Jahr, Fabrikarbeiter, war bis vor zwei Jahren ganz gesund. Hat dann allmählich zu husten angefangen, die erste Zeit ohne Auswurf und Fieber. Im März 1924 stellen sich asthmatische Anfälle ein, es tritt Fieber und Abmagerung hinzu. Der Husten verschlimmert sich und auch hat der Patient jetzt Auswurf, hauptsächlich am Morgen. Das Sputum hat keinen üblen Geruch, enthält ab und zu etwas Blut; es besteht keine mundvolle Expectoration. Bei der Spitalaufnahme im September wurden sehr wenig Abweichungen gefunden. Über beiden Lungen hypersonorer Percussionston; rechts sowie links einige bronchitische Geräusche, dabei in den unteren Partien vorne und hinten vereinzelte feuchte sehr kleinblasige Rasselgeräusche. Die Roentgenuntersuchung ergibt nur eine geringe Beweglichkeit der beiden Zwerchfellhälften. In der Klinik hat der Patient mässiges Fieber (38°). Das Sputum ist nicht übelriechend, zeigt beim Stehen keine

Schichtung, es enthält keine Tuberkelbazillen oder elastische Fasern, dagegen sehr viele Kokken. Die tägliche Menge ist etwa 100 c. M.^{3} Nach einigen Wochen Bettruhe und Behandlung mit Autovaccin, bereitet von aus dem Sputum gezüchteten Streptokokken, hört man nur noch ganz vereinzelte bronchitische Geräusche und in den unteren Partien einige ganz feine Rasselgeräusche. Da das Quantum Sputum sich immer gleich bleibt, wird die *Möglichkeit* erörtert, dass eine Bronchiectasenbildung vorliegt. Die Percussion und die Auscultation stützen aber diese Diagnose nicht.

Auch hier wird zur Klärung der Verhältnisse zur Lipiodolfüllung der Bronchien geschritten. Die nach Einführung von je 20 c. M.^{3} Lipiodol in den rechten und in den linken Hauptbronchus angefertigten Roentgenbilder (Fig. 2 und 3) zeigen uns sehr deutlich, dass wir es mit einer ausgebreiteten Bronchiectasenbildung zu tun haben. In beiden Unterlappen sieht man an mehreren Stellen spindelförmige Erweiterungen der mittleren Bronchien. Mit einem Schlage ist also die Diagnose sichergestellt, denn deutlicher wie auf dem Bilde 3 wird sogar der Pathologe-Anatom kaum je diese Abweichung zu Gesicht bekommen.

Diese zwei Fälle zeigen zur Genüge den grossen Fortschritt, welchen die Lipiodolfüllung für die Roentgenuntersuchung der Lunge bedeutet. Ich möchte diese Methode daher wärmstens empfehlen. Schwerwiegende Nachteile für die Patienten habe ich davon nicht gesehen und in der Literatur nicht gefunden. Jodismus, worüber DANIELSSON und MANFRED berichten, habe ich nicht gesehen bei unseren Patienten, nur einmal ist geringe Temperaturerhöhung eingetreten, die aber bald wieder abklang. Einmal sahen wir bei einer Patientin mit chronischer Bronchitis gleich nach der Untersuchung eine auffallende Besserung; die Sputummenge ging zurück von etwa 120 bis 30 c. M.^{3}

ZUSAMMENFASSUNG. Verfasser berichtet über die grossen Vorteile der Lipiodolfüllung der Bronchien bei Patienten mit Bronchiectasien.

SUMMARY. The writer reports on the great advantages of lipiodol injections into the bronchi of patients suffering from bronchiectasis.

RÉSUMÉ. L'auteur mentionne le grand avantage d'injection de Lipiodol dans les bronches des patients souffrants de bronchiectasis.

EINIGE UNTERSUCHUNGEN ÜBER VORRICHTUNGEN ZUM SCHUTZ GEGEN RÖNTGENSTRAHLEN

von

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So weit aus der Literatur ersichtlich, sind eingehendere Untersuchungen über die Strahlungen, die bei Verwendung von Röntgenröhren trotz scheinbar sorgfältig ausgeführter Schutzvorrichtungen durch die Wände des Röntgenzimmers hindurchdringen, bis jetzt noch nicht veröffentlicht worden. Zwar liest man zuweilen von Versuchen, sich auf photographischem Wege Klarheit über die Effektivität solcher Schutzvorrichtungen zu schaffen; diesem Verfahren dürften aber so viele Fehlermöglichkeiten anhaften, dass es so gut wie unbrauchbar ist, insbesondere wenn es sich um quantitative Bestimmungen handelt. Bei demselben werden bekanntlich in Papier eingewickelte Platten oder Filme während einer gewissen Zeit (Wochen — Monate) den Strahlen ausgesetzt. Beispielsweise pflegen in Röntgeninstituten die Ärzte und Krankenschwestern solche Proben mit sich zu führen, um an diesen das Maass, in welchem sie sich diesen Bestrahlungen aussetzen, zu erkennen. Die Auswertung der Resultate erfolgt dann natürlich durch Vergleiche mit in der gleichen Weise verpackten, aber unbestrahlt gebliebenen Proben, die gleichzeitig mit jenen und in demselben Entwickler entwickelt werden. Der Hauptnachteil dieses Verfahrens besteht darin, dass unsre Kenntnisse über den Zusammenhang zwischen Strahlungsmenge (Intensität × Zeit) und Schwärzung der photographischen Schicht noch sehr unvollständig sind, besonders wenn es sich, wie hier, um kleine Intensitäten und intermittente Bestrahlung handelt.

Im folgenden Aufsatz sollen einige, mit einem einfachen Ionisations-Instrument ausgeführte Untersuchungen, die bei vier der grösseren Röntgeninstitute in Stockholm vorgenommen worden sind, beschrieben werden. Bei denselben konnte mehrfach festgestellt werden, dass ein bedeutend effektiverer Schutz hätte erreicht werden

können, wenn das Schutzmaterial zweckmässiger verteilt gewesen wäre, ohne dass dabei die Schutzvorrichtungen teurer geworden wären. Oft scheint man die Sekundärstrahlung der Wände, des Bodens und der Decke unterschätzt zu haben, indem die Schutzwände sich meistens so gut wie ausschliesslich auf die Herabsetzung der Intensität der direkten Strahlen beschränkten. Die Untersuchungen mögen einen Beitrag dazu bilden, auf empirischer Grundlage die Mindestforderungen, die bei der Therapie und der Diagnostik an den Schutz gegen Röntgenstrahlen gestellt werden müssen, zu bestimmen.

Zu sämtlichen hier angeführten Intensitätsbestimmungen wurde ein Instrument benutzt (siehe Fig. 1), das aus einem Elektroskop mit sehr kleiner Elektroden-Kapazität bestand, an welchem Ionisationskammern verschiedener Grösse I, II und III mit einem Volumen von bzw. 15, 150 und 1 500 cbcm angeschlossen werden konnten. Zusammengenommen ergaben diese also ein sehr ausgedehntes Messgebiet. Das Elektroskop war ein nach ISING konstruiertes. Der bewegliche Teil desselben bestand aus einem Phosphorbronzedraht von sehr geringem Durchmesser, der an seinem oberen Ende an einem ca. 1 mm starken Kupferdraht befestigt war. Das Elektroskop war an allen Seiten von 3 mm Blei eingeschlossen, mit Ausnahme der gegen die Ionisationskammer gerichteten Seite, an der ein Schutz von 4 mm Blei angebracht war. Die Wände sämtlicher Ionisationskammern bestanden aus $^1/_2$—1 mm dickem Aluminium-Blech. Zu jeder Ionisationskammer gehörte ein 2 mm starker Bleischutz in Form eines der Länge nach durchschnittenen Cylinders, mit dessen Hilfe die Strahlung von jeder beliebigen Richtung her abgeschirmt werden konnte. Die Elektroden der Kammern waren mit Bernstein isoliert und mit Schutzring versehen.

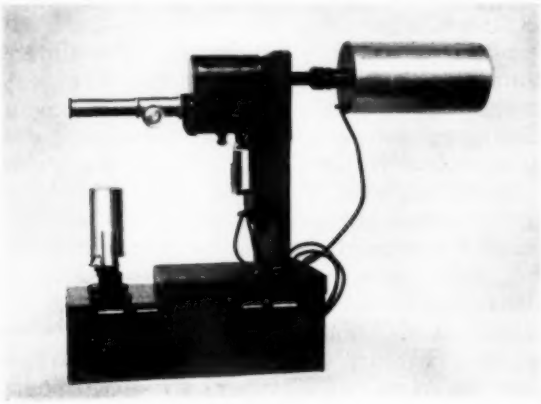


Fig. 1.

Mit Hilfe einer Volta'schen Säule wurden die Kammerwände gegen den Mantel des Instrumentes auf ein Potential von + 120

Volt gehalten, während ein beweglicher Arm das Aufladen der Elektroskopnadel bis — 50 Volt ca. ermöglichte. Dabei erhielt man (bei 100-maliger Vergrösserung des Ablesemikroskopes) einen Anfangsausschlag von ca. 30 Skalenteilen. Bei sämtlichen Messungen wurde die Ablaufzeit für die ersten 10 Skalenteile ermittelt, und ergaben die mit einem Radiumpräparat vorgenommenen Kontrollversuche (s. unten Tabelle 3), dass bei sämtlichen Kammern, sogar bei nur wenigen Sekunden Ablaufzeit, Sättigungsstrom erreicht wurde. Wie aus nebenstehendem Schema (Fig. 2) hervorgeht, war eine Erdleitung nicht nötig, was besonders bei schnellen Messungen an verschiedenen Plätzen sehr von Vorteil ist. Zur Beleuchtung des Elektroskopfadens diente eine durch eine elektrische Taschenlampen-Batterie gespeiste Glühlampe.

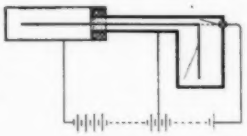


Fig. 2.

Die Messungen einer und derselben Röntgenstrahlung mit jeder der 3 Kammern ergaben folgende Resultate:

Kammer	I	II	III	
Ablaufzeit in sec.:	200	30	5	(1)

Um den Zusammenhang zwischen den beobachteten, meistens sehr kleinen Strahlungsintensitäten und den bei Röntgenbehandlung vorkommenden Intensitäten festzustellen, wurde die Intensität bei einem Abstand von der Röntgenröhre von 12 Meter gemessen; letztere war mit 3 mm Kupferfiltrum versehen und wurde bei 200,000 Volt mit 6 Milliampère betrieben. Die Messungen erfolgten bei gegen ein Fenster gerichtetem Strahlenbündel auf der Strasse, und wurden hierbei mit Kammer II ca. 10 Sekunden Ablaufzeit erhalten. Unter den gleichen Betriebsbedingungen erhält man auf 1 Meter Abstand eine HED-Zeit von ungefähr 1000 Minuten. Der Begriff HED-Zeit muss in diesem Aufsatz als ein physikalisches Maass betrachtet werden. Bei deren Berechnung geht man von der Bestrahlungszeit aus, die bei einer einmaligen Bestrahlung nötig ist, um ein Hauterytem zu erreichen. Hieraus ist die bei 3 mm Kupferfilterung festgestellte HED-Zeit nach Jontoquantimeterbeobachtungen abgeleitet. Die HED-Zeit bei 12 Meter Abstand ist dann nach dem Quadratgesetz berechnet.

Mit Hilfe der obenerwähnten Werte lassen sich folgende Konstanten errechnen, die bei Multiplikation mit den Ablaufzeiten die betr. HED-Zeit in Stunden ergeben:

Kammer	I	II	III	
C	40	250	1500	(2)

Zwecks Kontrolle des Instrumentes wurden von Zeit zu Zeit Beobachtungen mit Radiumpräparaten (3 mm Bleifiltrum) vorgenommen. Hierbei ergaben sich u. A. folgende Zeitwerte:

Abstand	Ra-Quantität		Kammer	I	II	III	
cm:	mgr:	2.26	sec:	110	36		
10		5.14		45	15½		
		8.79		27	9		
		1.13			230	43½	(3)
20		2.12			123	22	
		4.38			63	11¼	
		8.79			35	6¼	

Die Verhältnisse der mit den verschiedenen Ionisationskammern erhaltenen Zahlen sind in (1) nicht dieselben wie in (3), was darauf zurückzuführen ist, dass zufolge der bedeutend grösseren Durchdringungsfähigkeit der Radiumstrahlen gegenüber den Röntgenstrahlen eine kräftigere Ionisation im Elektroskop nebst dessen Zuleitungen hervorgerufen wurde. Beiläufig erwähnt, ergaben obenstehende Zahlen, dass zur Erzielung einer HED in 24 Stunden mit einem Radiumpräparat auf 10 cm Abstand eine Radiummenge von der Grössenordnung 1 gr Radiumelement erforderlich ist.

Ehe wir auf die Resultate der Messungen eingehen, dürfte es am Platze sein, vom physikalischen Standpunkte aus einige Worte über die Bedeutung sehr kleiner Bestrahlungen vorauszuschicken. Es ist hierbei zu unterscheiden zwischen solchen, die durch weiche Strahlen zustandekommen und nur wenige Centimeter tief in den Körper eindringen, und solchen von harten Strahlen, die eine Totalbestrahlung des Körpers bewirken. Erstere kommen wohl nur bei der Diagnostik in Frage; doch dürften die Schutzvorrichtungen heute solche sein, dass eine in dieser Hinsicht gefährliche Bestrahlung im allgemeinen nicht mehr zu befürchten ist.

Was aber die erwähnte Totalbestrahlung betrifft, so hat man von biologischer Seite her, streng genommen, wohl noch keine bestimmte Auffassung von deren Wirkungen. Trotzdem scheint es eine Möglichkeit zu geben, dieses Problem ausschliesslich vom Gesichtspunkte der Wahrscheinlichkeit zu betrachten.

Untersuchungen über die Wirkung physikalisch gleicher Strahlungsmengen bei verschieden langen Bestrahlungszeiten deuten darauf hin, dass bei kurzen Zeiten und grossen Intensitäten grössere biologische Veränderungen zu erwarten sind, als bei langen Zeiten und kleinen Intensitäten. Dies ist aber nichts anderes, als was man immer bei biologischen Strahlenwirkungen (ultraviolette Strahlen,

Wärmestrahlen) beobachten kann, wenn man von ganz kurzen Bestrahlungen von nur wenigen Sekunden absieht. Auch ist ja der Körper ständig kleinen Quantitäten aller möglichen Strahlungen ausgesetzt, so dass man a priori als gegeben hinstellen kann, dass bei einem Sinken der Strahlungsintensitäten unter ein gewisses Maximum von einer Schädlichkeit der Strahlen überhaupt nicht mehr die Rede sein kann. So wissen wir z. B., dass eine von der Erde ausgehende, harte γ-Strahlung überall nachgewiesen werden kann. Dieselbe ruft in jedem cbcm Luft eine Ionisierung von der Grössenordnung 1—10 Ionen pro sec. hervor. Die HED-Zeit dieser ausserordentlich schwachen »natürlichen» Bestrahlung lässt sich auf 10,000—1,000 Jahre berechnen.

Nehmen wir an, dass die Bestrahlung des Patienten bei Behandlung mit 1 HED und ordinärem Felde keine bleibenden, schädlichen Veränderungen hervorruft, so dürfte es erlaubt sein, die Behauptung aufzustellen, dass man sich bei so schwachen Bestrahlungen, wie die durch eine einigermassen gute Schutzwand dringende, gefahrlos jährlich wenigstens $^1/_{10}$ HED aussetzen kann. Wie viele Stunden werden aber die mit Röntgenstrahlen arbeitenden Ärzte und Pflegerinnen während eines Jahres bestrahlt? Man dürfte hierfür folgende Zahlen als Maximum annehmen können:

bei Röntgenaufnahmen: 25 Stunden pro Jahr
» Röntgendurchleuchtungen: 500 » » »
» Röntgentherapie: 1500 » » »

Soll in diesen 3 Fällen die ungewollte Strahlung weniger als $^1/_{10}$ HED ausmachen, müssen die Schutzvorrichtungen so effektiv sein, dass die HED-Zeit:

bei Röntgenaufnahmen: 250 Stunden
» Röntgendurchleuchtung: 5000 »
» Röntgentherapie: 15000 »

nicht übersteigt.

Die »natürliche» Bestrahlung beträgt pro Jahr $^1/_{1000}$—$^1/_{10000}$ HED, was für Vergleiche von Interesse sein dürfte.

Sämtliche Resultate der Intensitätsbeobachtungen sind in Fig. 3—8 in anschaulicher Weise zusammengestellt. Die Betriebsbedingungen sind für jede einzelne Röntgenröhre an ihrer Betriebsstelle angegeben.

Dabei bedeutet:

F. A. Durchleuchtungsstativ nach Forssell bei Aufnahmen.
F. D. Durchleuchtungsstativ nach Forssell bei Durchleuchtungen.
A. S. Diagnostik-Tisch nach Albers-Schönberg.
T. Trochoskop-Tisch nach Forssell.
P. Diagnostik-Tisch nach Potter-Bucky.

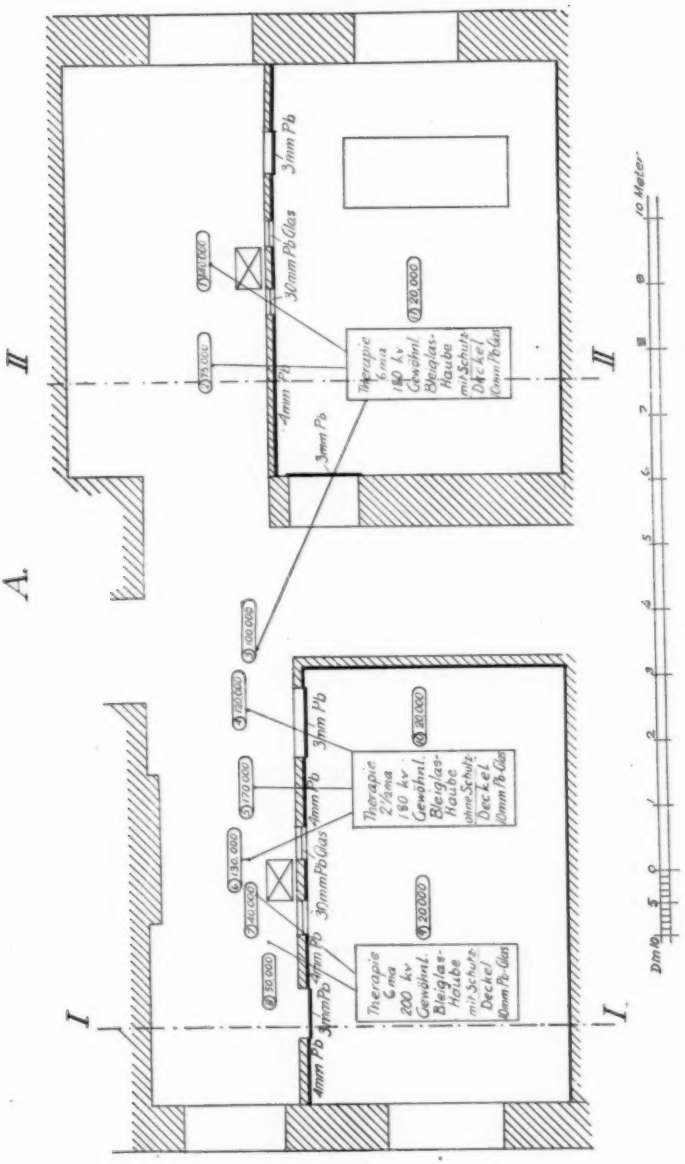

A.
I
I.
II
II.
Therapie 6 ma 180 kv Gewöhnl. Bleiglas-Haube mit Schutz Deckel (3mm Pb Glas
Therapie 2½ ma 180 kv Gewöhnl. Bleiglas-Haube ohne Schutz Deckel 10mm Pb Glas
Therapie 6 ma 200 kv Gewöhnl. Bleiglas-Haube mit Schutz Deckel 10mm Pb Glas
3mm Pb
4mm Pb
30mm Pb Glas
10 Meter

Fig. 3.

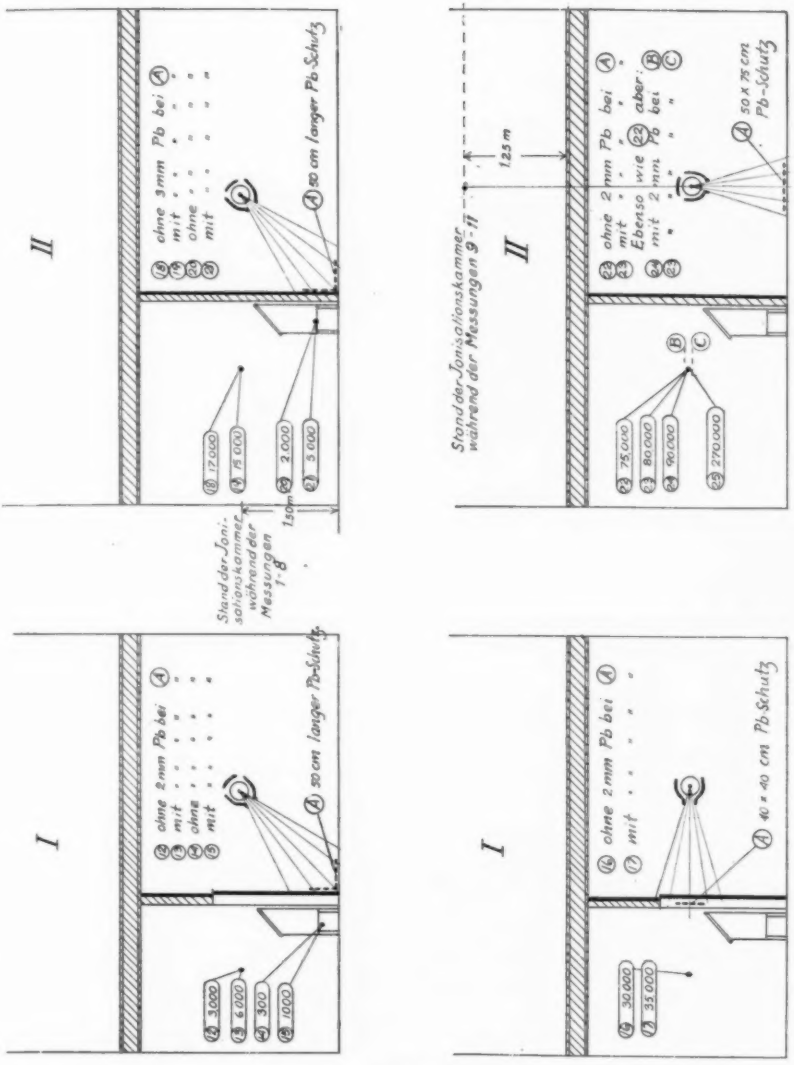

I
II
ohne 3mm Pb bei A
mit " " " "
ohne " " " "
mit " " " "
A 50 cm langer Pb-Schutz
17.000
18.000
2.000
3.000
Stand der Ionisationskammer während der Messungen 1-8
1.5 m
ohne 2mm Pb bei A
mit " " " "
ohne " " " "
mit " " " "
A 50 cm langer Pb-Schutz
3.000
6.000
300
1.000
Stand der Ionisationskammer während der Messungen 9-11
1.25 m
ohne 2mm Pb bei A
mit " " " "
Ebenso wie aber
mit 2mm Pb bei B C
A 50 x 75 cm Pb-Schutz
75.000
80.000
90.000
270.000
ohne 2mm Pb bei A
mit " " " "
A 40 x 40 cm Pb-Schutz
30.000
35.000

Fig. 4.

B.

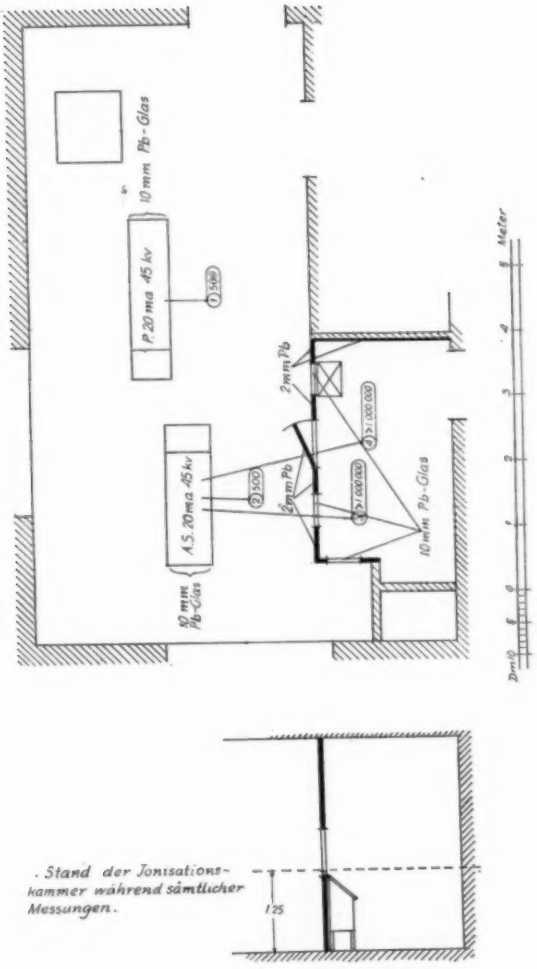
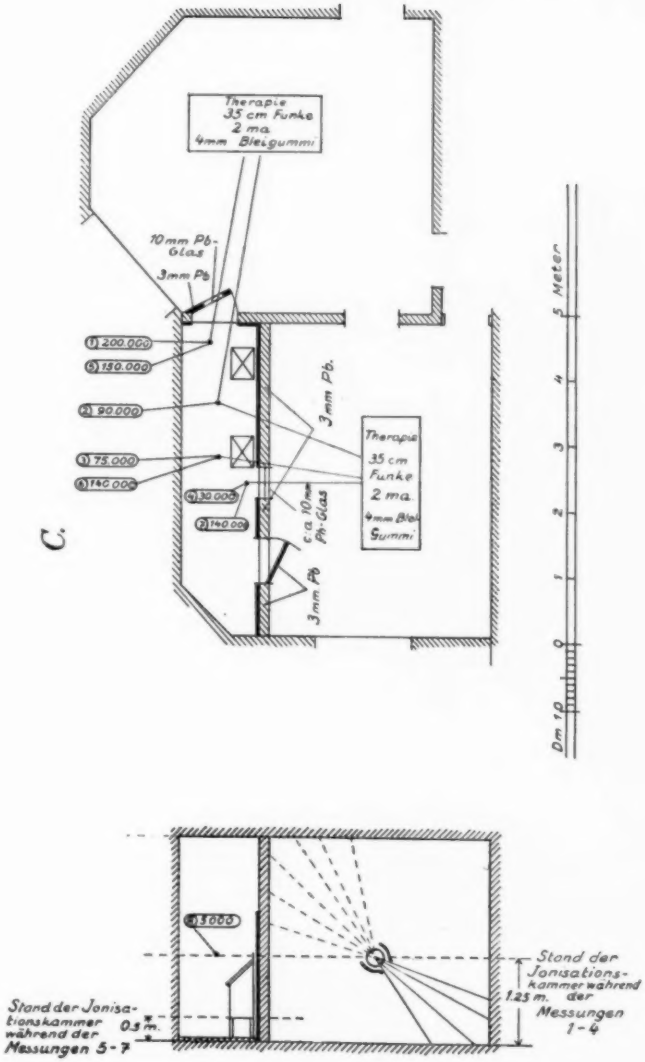

10 mm Pb-Glas
P. 20 ma 45 kv
1 500
2 mm Pb
A.S. 20 ma 45 kv
2 500
2 mm Pb
3 1 000 000
4 1 000 000
10 mm Pb-Glas
10 mm Pb-Glas
Meter
Stand der Jonisations-kammer während sämtlicher Messungen.
125

Fig. 5.


Therapie
35 cm Funke
2 ma
4mm Bleigummi
10mm Pb-Glas
3mm Pb
1) 200.000
5) 130.000
2) 90.000
3) 75.000
4) 140.000
6) 140.000
3mm Pb
Therapie
35 cm
Funke
2 ma
4mm Blei
Gummi
c.a. 10mm Pb-Glas
3mm Pb
C.
5 Meter
4
3
2
1
0
Dm 10

3) 75.000
Stand der Jonisationskammer während der Messungen 5-7
0.3 m.
Stand der Jonisationskammer während der Messungen 1-4
1.25 m.

Fig. 6.

D.

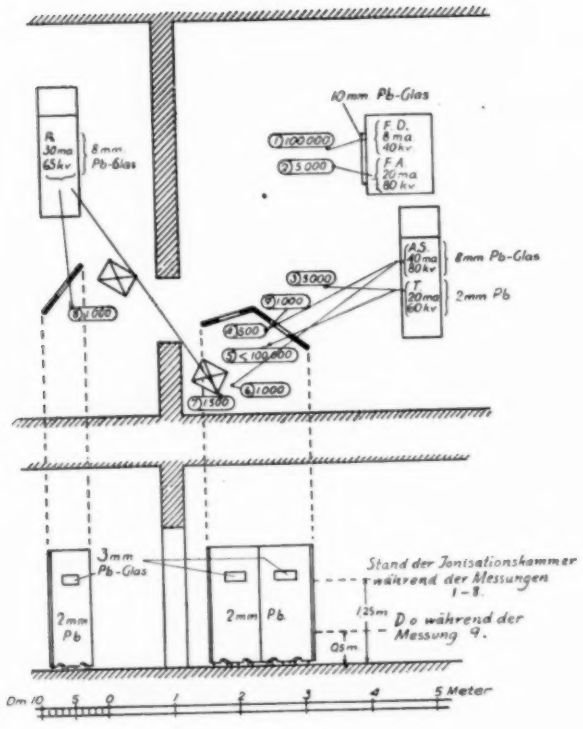

R
30ma
65kv
8mm
Pb-Glas
10mm Pb-Glas
F.D.
8ma
40kv
F.A.
20ma
80kv
1) 100 000
2) 5 000
A.S.
40ma
80kv
T
20ma
80kv
8mm Pb-Glas
2mm Pb
3) 5000
4) 1000
5) 800
6) < 100 000
7) 1000
8) 1500
9) 1000
3mm
Pb-Glas
2mm
Pb
2mm Pb
Stand der Ionisationskammer
während der Messungen
1–8.
1,25m
0,5m
Do während der
Messung 9.
Dm 10 5 0 1 2 3 4 5 Meter

Fig. 7.

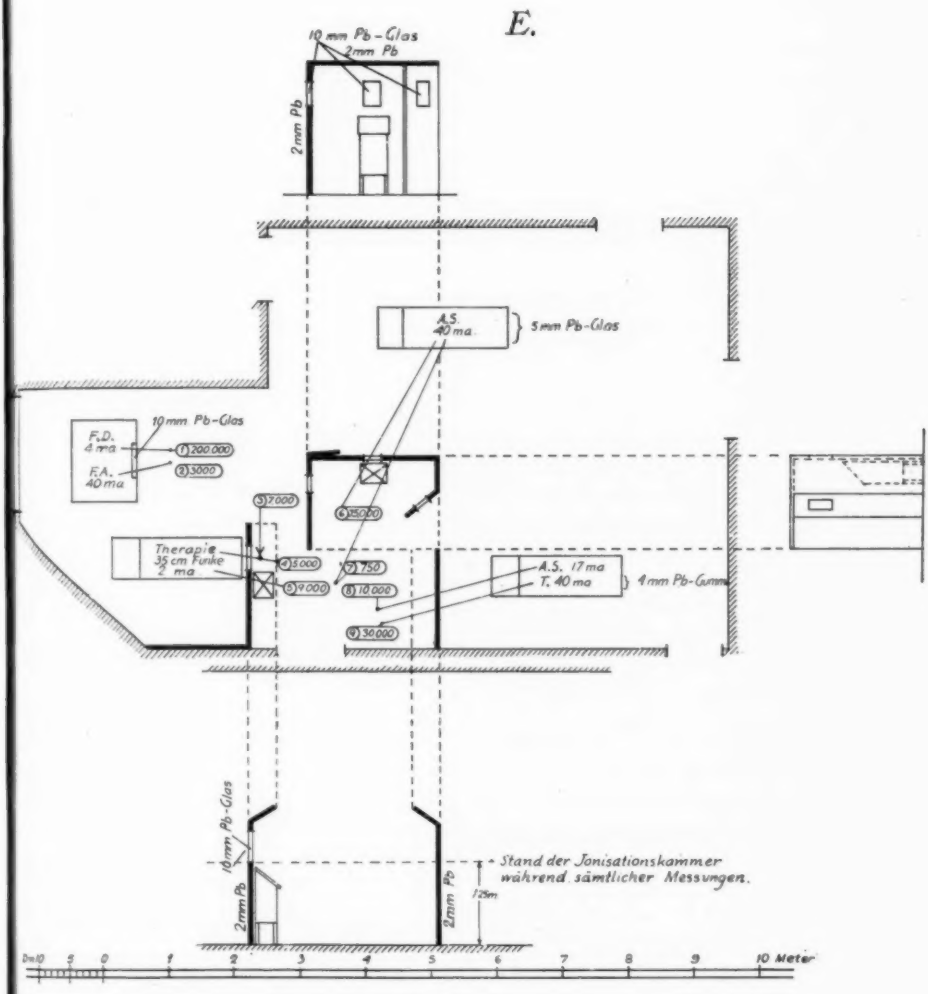

E.
10 mm Pb-Glas
2mm Pb
2mm Pb
A.S. 40 ma
5 mm Pb-Glas
10 mm Pb-Glas
F.D. 4 ma
F.A. 40 ma
1) 200.000
2) 3000
3) 7000
6) 150.000
Therapie 35 cm Funke 2 ma
4) 5000
5) 9000
7) 750
8) 10.000
9) 30.000
A.S. 17 ma
T. 40 ma
4 mm Pb-Gumm
10mm Pb-Glas
2mm Pb
2mm Pb
Stand der Jonisationskammer
während sämtlicher Messungen.
125m
Dm 10 5 0 1 2 3 4 5 6 7 8 9 10 Meter

Fig. 8.

An den Punkten, an denen die Beobachtungen vorgenommen wurden, sind die HED-Zeiten in Stunden angegeben. Wo nicht anders angegeben, war das Strahlenbündel der Röhre stets gegen den Boden gerichtet. Mit Hilfe der den Skizzen angefügten Erläuterungen dürfte es keine Schwierigkeiten bieten, sich ein Bild über die Ausführung der Messungen zu machen.

Zu den verschiedenen Planzeichnungen ist noch folgendes zu erwähnen:

Plan A. Mehr als genügend Schutz ($^1/_{20}$—$^1/_{100}$ HED pro Jahr) gegen direkte Strahlung und im allgemeinen auch gegen Sekundärstrahlung, was sowohl Bleiglas wie Bleibekleidung anbelangt. Ungenügender Schutz gegen Sekundärstrahlen nur in dem Falle, dass das Strahlenbündel auf die Begrenzungslinie zwischen Bleiwand und Boden hin gerichtet ist (1—5 HED pro Jahr). 3 mm Blei in den Schutzwänden, sovie Bleischutz am Boden (s. weiter unten) wäre vielleicht zweckmässiger gewesen.

Plan B. Mehr als genügend Schutz in jeder Beziehung. ($< {}^1/_{10000}$ HED pro Jahr).

Plan C. Mehr als genügend Schutz ($^1/_{20}$—$^1/_{100}$ HED pro Jahr), vorausgesetzt, dass eine Röhrenstellung, wie bei Messung 4, nicht zu oft vorkommt ($^1/_3$ HED pro Jahr).

Plan D. Genügend Schutz ($^1/_{10}$—$^1/_{2000}$ HED pro Jahr). Ein fester, mit Decke versehener Schutzraum, z. B. in der Ecke am Platze der Messung 7, würde den Schutz jedoch wesentlich verbessern.

Plan E. Soweit es die Diagnostik betrifft, genügend Schutz ($^1/_{30}$—$^1/_{1500}$ HED pro Jahr). Für die Therapie ungenügender Schutz ($^1/_3$—$^1/_6$ HED pro Jahr). Ein gemeinsamer Schutzraum, etwa $2^1/_2$—3 Meter hoch und mit bleibekleideten Wänden, Türen und Decke versehen, wäre vorzuziehen gewesen.

Wir wollen jetzt auf Grund der erhaltenen Messresultate versuchen, einige Schlussfolgerungen über folgende Fragen zu ziehen:

1) Wie gross muss die Schutzfähigkeit der Wände sein, wenn es sich um Diagnostik, und wie gross, wenn es sich um Therapie handelt?

2) Wie weit müssen sich in beiden Fällen die Schutzwände ausdehnen?

3) Ist es notwendig, Boden und Decke mit Schutzmaterial zu bekleiden?

4) Wie stark muss der, die Röntgenröhren umgebende Schutz sein?

Auf die erste Frage geben, so weit es die Therapie anbelangt, die Messungen A: 1—8, 16, 17, C: 1—7 Antwort. Dieselben zeigen deutlich, dass die direkten Strahlen auch bei der modernen Tiefentherapie schon bei einer Schutzfähigkeit von 3—4 mm Blei (30—40 mm Bleiglas) sehr effektiv vermieden werden. Ausserdem dürfte aus denselben

hervorgehen, dass eine Verstärkung der Schutzwände über die genannte Dicke hinaus nur dann für zweckmässig gelten darf, wenn die sekundären Strahlen, von denen weiter unten noch die Rede sein wird, so vollständig abgeschirmt sind, dass die direkte Strahlung einen grossen Teil der totalen Strahlung ausmacht.

Bei der Diagnostik dürften $1^1/_2$—2 mm Blei (15—20 mm Bleiglas) mehr wie genügend Schutz bieten, wie dies aus den Messungen B: 3, 4, E: 6 hervorgeht.

Nach Glocker (Fortschr. a. d. Gebiete d. Röntgenstr. 32, 1924, S. 166) sollen 50 cm Ziegel 4—5 mm Blei entsprechen. Eine Ziegelwand von 30—40 cm Dicke sollte demnach einen vortrefflichen Schutz gegen Röntgenstrahlen bilden, was auch in der Tat durch Beobachtungen im Radiumhemmet bestätigt ist. Sehr wahrscheinlich liegt die Effektivität hierbei zum grössten Teil darin, dass die Wand sowohl nach oben wie nach unten weiterverläuft, wodurch Sekundärstrahlungen von den Kanten her, wie weiter unten beschrieben, vollständig ausgeschlossen sind.

Mit Bezug auf die Ausdehnung, die die Schutzwände haben müssen, um die ungewollten Strahlungen genügend abzuschirmen, ist zu erwähnen, dass die von Wände, Boden und Decke des Röntgenzimmers ausgehende sekundäre Strahlung eine viel grössere Rolle spielt, als man im allgemeinen anzunehmen geneigt ist. Die Beobachtungen A: 12—15, 18—21, C: 8, D: 4, 6, 8, E: 3—5, 7—9 zeigen, dass es sowohl bei der Therapie als bei der Diagnostik von Vorteil ist, venn sich die Schutzwände vom Boden bis zur Decke erstrecken, und in der Breite wenigstens die Sekundärstrahlung von den Wänden, die sich auf geringerem Abstand von der Röhre, als 2—3 Meter befinden, fernhalten. Ist der Boden nicht mit Schutzmaterial belegt, muss bei der Therapie auf die Kanten, wo die Wände mit Boden und Decke zusammenstossen, ganz besonders geachtet werden. Aus den Beobachtungen geht nämlich deutlich hervor, in welchem Maasse sich eine vom Boden ausgehende Sekundärstrahlung bemerkbar machen kann, wenn das Schutzmaterial der Wand über oder an der anstossenden Bodenfläche endet. Eine nennenswerte Verbesserung des Schutzes kann erreicht werden, entweder indem man die Schutzwand um 5—10 cm unter den Plan des Bodens verlängert, oder indem man einen 30—50 cm breiten Streifen des Bodens auf beiden Seiten der Wand mit Schutzmaterial belegt. Sind die Türen Schiebetüren, kann man diese mit Vorteil mit einer in einer Rinne im Boden eingelassenen, bleibekleideten Leiste versehen, was wohl ohne grössere Kosten ausführbar ist. Man könnte auf den Gedanken kommen, dass durch Belegen des Behandlungstisches mit Schutzmaterial die erwähnten Uebelstände beseitigt werden könnten. Dies

dürfte aber, in grösserer Ausdehnung wenigstens, nicht der Fall sein, es sei denn in besonderen Fällen, wie bei Behandlung auf kurze Abstände, wenn der Behandlungstisch winkelrecht zur Wand und ziemlich nahe derselben steht (vergl. A: 22—23). Es ist zu merken, dass die hier in Rede stehende Sekundärstrahlung nicht nur von dem eigentlichen Strahlenbündel, sondern auch von der durch die Schutzhaube dringenden Strahlung herrührt.

Boden und Decke brauchen selbstverständlich nur dann mit Schutzmaterial bekleidet zu werden, wenn sich in den Lokalen über dem betr. Röntgenzimmer ein und dieselben Personen öfters aufhalten. Für diesen Fall scheint eine von FORSSELL vorgeschlagene, im Radiumhemmet benutzte Bodenfüllung aus Barium sehr zweckmässig zu sein. Nach GLOCKER sollen 25 cm gewöhnl. Betons eine Absorptionsfähigkeit von ca. 4 mm Blei besitzen. Bei gewöhnlichen Beton-Böden von über 20 cm Dicke wäre demnach ein besonderer Schutz nicht erforderlich.

Bezüglich der die Therapieröhre umgebenden Schutzhaube erfordert die intensive Erhitzung der Antikatode bei den modernen luftgekühlten Coolidge-Röhren, sofern keine besondere Ventilationsvorrichtung vorhanden ist, dass die Haube durchsichtig ist und die Röhre nicht von allen Seiten einschliesst. Schon ein Bleiglasdeckel an der Rückseite der Röhre, wie in Fig. 4 angedeutet, beeinflusst die Röhre in nachteiliger Weise. Hat man aber keinen Schutz auf der Rückseite der Röhre, muss auf die Strahlung, die in beträchtlicher Menge in die über dem Röntgenzimmer befindlichen Räume dringt, besonders Rücksicht genommen werden.

Die besten Bleiglas-Hauben haben ein Schutzvermögen, das 1—2 mm Blei gleichkommt, was dem Patienten einen vollständig ausreichenden Schutz gegen zu starke Totalbestrahlung bietet, insbesondere wenn man den Patienten, wie dies bei uns allgemein üblich ist, grösstenteils mit einer 2—4 mm dicken Bleigummischicht bedeckt. Die sehr zweckmässigen, aber unbequemen grossen Schutzkästen, die die Röhre von allen Seiten umgeben und mit Kühlanordnung versehen sind, haben in unserm Lande noch keinen Eingang gefunden; allerdings sind die Verhältnisse hier ganz andere.

Hinsichtlich der Strahlung in nächster Umgebung der Röntgenröhren wird auf die Fig. 3—8 hingewiesen.

ZUSAMMENFASSUNG

Es ist mit einem Ionisations-Instrument die durch Schutzvorrichtungen dringende Röntgenstrahlung untersucht worden. Die Messresultate sind in Planzeichnungen der Röntgenabteilungen in übersichtlicher Weise eingetragen

Aus denselben geht u. a. hervor, dass man die Sekundärstrahlungen von Wänden, Boden und Decke im allgemeinen bisher nicht genügend berücksichtigt hat. Gegen diese Strahlungen werden einige Schutzanordnungen vorgeschlagen.

SUMMARY

The radiation penetrating the protective arrangements against roentgen rays has been examined by means of an ionization instrument. The results of observation have been perspicuously transferred to plans of the roentgen departments where the measurements have been done. These show, inter alia, that the secondary radiation from walls, floor, and ceiling have hitherto been generally underrated. Some protective arrangements against these rays are suggested.

RÉSUMÉ

On a étudié, à l'aide d'un instrument d'ionisation, l'irradiation qui traverse les appareils protecteurs contre rayons X. Le résultat de ces observations a été synoptiquement reporté sur les plans de services dans lesquels les mensurations ont été faites. Il ressort, entre autre, de ces résultats que l'on n'a généralement pas tenu suffisamment compte des rayons réfléchis par les murs, le sol et le plafond. L'auteur propose divers dispositifs de protection contre cette catégorie de rayons.

PROCEEDINGS OF THE DUTCH SOCIETY FOR ELECTROLOGY AND RÖNTGENOLOGY

48th meeting in Amsterdam 13th April 1924.

President: Dr. P. J. Ph. DIETZ.
Secretary: Dr. N. VOORHOEVE.

I. Obituary.
The president regrets the death of Dr. F. HOEKSTRA.

II. J. W. F. JANSEN: *Special Cases of Enchondromata.*
(Will be published in Acta Radiologica.)

Discussion. DIETZ cannot agree with the speaker that the radiograph shows that the sella turcica of the first patient is enlarged.

STENVERS also thinks that the size of this sella lies within normal limits.

JANSEN points to the wide entrance and the posterior border.

DIETZ and STENVERS think that notwithstanding this, the sella is of normal size.

DIETZ agrees with speaker that a trauma may have some influence on the development of an enchondroma. He saw a similar case of a boy showing an enchondroma following a trauma of the leg. Afterwards exarticulation become necessary and the diagnosis was confirmed by anatomical examination. Afterwards the affection was proved to have become malignant, as metastases in the lungs developed, from which the patient subsequently died.

III. L. G. HEILBRON: *Discussion of the Punktwärmetheorie of Dessauer.*
(Will be published in extenso.)

Discussion. VALKEN also has objections to the theory of DESSAUER. When X-rays strike tissues, there are three possibilities. Secondary rays arise, or electrons are detached, or the nucleus of an atom is hit, which produces heat. It is a chance which of these three things may happen, and DESSAUER thinks the last occurs most frequently, but he does not give any proof of it. His statement is even contradictory to experience. Indeed, if the heat produced at one point is the cause why tissues react to X-rays, the sensibility to the rays will be increased according as the heat is carried off

more slowly as is the case when the velocity of the blood is diminished or when the tissues contain a smaller quantity of blood. Experience, however, teaches us that tissues containing much blood are more sensible to X-rays than those containing less blood. A second objection is that MADELUNG has shown that the mathematical calculations made by DESSAUER for his theory are wrong.

STEENHUIS observes that he does not want to defend the theory of DESSAUER, but that VALKENS last conclusion goes too far. When MADELUNG disputes the mathematical calculations of DESSAUER, we may for the present only conclude that MADELUNG does not agree with DESSAUER, but not that DESSAUER is wrong.

HISSINK makes a few remarks on the validity of the law of ARNDT-SCHULTZ. It is a fact that the total organism may be stimulated into action by X-rays; indeed, the same kind of X-rays may cause the falling off of normal hairs and cure diseases of the hair and so stimulate its growth.

HEILBRON does not believe in the stimulating effect of X-rays. We must first of all define the word stimulation. He thinks with HOLZKNECHT that the word has too many meanings and for that reason has caused much confusion.

WIENER points to the stimulating effect of X-rays in cases of alopecia areata.

LAMMERS often saw carcinomata growing faster when insufficiently irradiated. He ascribes this to the stimulating effect of the X-rays.

HEILBRON newer saw any real proof of this effect on carcinomata; the cases in literature are not above criticism; the same is the case with seeds and plants.

DIETZ observes that up to a short time ago, deep carcinomata received an insufficient dosis and if a stimulating dosis really did exist, the X-rays would have had a bad effect in allmost all cases. Nevertheless, this was not the case. It is to the credit of HOLZKNECHT and his school that they have pointed out how wrong it is to use the terms stimulating effect in the way it has often been employed.

HISSINK observes that the faster growing of a tumor after radiation does not prove a stimulating effect on the diseased cells, but may equally well be caused by a diminishing of the resisting power of the healthy surrounding cells.

JANSEN points out the significance of inflammation in the parts surrounding the carcinoma. By radiation the inflammation may increase and facilitate secondary growth.

VOORHOEVE underlines the remarks of HISSINK. Uptill now the mistake has been that everybody has been repeating the words of everybody else and speaking of stimulating effect. HOLZKNECHT has fought against this dogma and shown that in all cases a solely destroying influence may explain, a biological phenomenon just as well as a stimulating effect. In his last communication he explains the action on alopecia areata, as quoted by WIENER, as being caused by the destroying influence exercised by the rays on the tissues, that prevent the growing of the hair. It causes confusion, when different ideas are expressed by the term stimulating effect. As matters stand at present, we may say that there are no proofs of a stimulating effect of X-rays. However we cannot deny that such proofs may possibly be found in the future.

IV. D. J. STEENHUIS: *Particulars about X-Ray Examination of the Skull.*

Speaker demonstrates a few rare cases which may perhaps give rise to new methods of examination.

1. The examination of the foramen opticum. After the case of an enlargement of the foramen opt. in a case of growth, communicated at the last meeting two communications on this subject appeared, one from WHITE in the Transactions of the American Academy of ohpthalmology and one from CUSHING and MARTIN in the Archives of ohpthalmology.

CUSHING examined the sella turcica and measured the dilatation near the proc. clinoideus. In consequence of this communication speaker tried to render the central part of the canalis opticus visible separately, because of the possibility that this kind of examination might teach us something in cases of the early stage of affections of the hypophysis. For this purpose he turns the skull about 10 or 20 degrees. The central part of the canalis opt. then becomes visible more or less distinctly, according to whether the canalis opt. lies more in the roof of the orbit or nearer to the proc. clinoideus. Stereoscopically it is easy to look into the opening and to get an idea of its dimensions. In the case of the patient with RECHLINGHAUSENS disease, reported before, the foramen is very much enlarged. Although there must be a preceding examination in an oblique position after the method of RHESE, this method of examination may give a good image of the central part of the canalis opticus.

2. A patient who entered the hospital complaining about bad eyesight, and who had an atrophy of the optic disc and a diminished field of vision, showed on examination in a bitemporal direction the absence of the sella turcica. Speaker often observed a difference of image when radiographing from left to right or from right to left and this is the reason why he also examined the patient in the other direction and could find a thin line showing many breaks and indicating the place of the sella turcica. The sphenoidal sinus was opaque, with undistinct lower border. So there existed an affection of the pituitary gland and of the sinus, most probably a tumor or mucocele. The autopsy showed an adeno-carcinoma of the pituitary gland and of the sphenoidal sinuses. KNOX in the "Archives" of some time ago, was right, when advising to radiograph from both sides in a bitemporal direction.

3. In connection with the former case, a case of a pure tumor of the pituitary gland with free sinus is described and also a case of a mucocele of the sphenoidal sinuses.

4. Radiographs are demonstrated of a patient who entered the hospital with symptoms pointing to a tumor in the ponto-cerebellar angle: choked disc, blindness of the left eye and diminished power of hearing of the left ear. The radiograph showed an enlarged sella turcica, a somewhat opaque sinus and perhaps a somewhat enlarged meatus acusticus internus. Speaker tried to project the petrous portion of the temporal bone in postero-anterior direction in the orbit, and found distinct differences between right and left. The autopsy confirmed the diagnosis.

5. A case of tower skull.

Discussion. NOORDENBOS observes, that in cases of tower skull much importance has been attached to the size of the optic foramina, and so methods

of operations have been invented to enlarge them. Now we know that it is better to make a common decompression and to leave the optic canals alone.

STENVERS thinks we must be very careful in judging radiographs of the petrous bones in postero-anterior direction.

STEENHUIS answers that he does not mean this direction to be used exclusively for examination of the petrous bones, but thinks that examination in this direction may be used to complete the results of radiographs taken from anoth r direction.

V. F. G. DE WILDE: *Demonstrations of Florid Cases of Gastric and Duodenal Ulcer.*

Speaker demonstrates a series of radiographs of patients suffering from ulcer of the lesser curvature with niche; one case without a niche, showing a deep contraction of the greater curvature. Two cases with very large niches and rapid passage through the pylorus, contrary to the ordinary rules. As an introduction to a series of radiographs of duodenal ulcers, speaker demonstrates serial radiographs of the normal bulbus duodeni, of a normal bulbus lying close to a gallbladder with stones; then some cases of ulcer with niche, some of them with a contraction at the opposite side of the bulbus, and finally some serial radiographs showing only a contraction at the curvatura major side of the bulbus. In all these cases, the diagnosis was proven correct by operation.

In all these cases of duodenal ulcer, the stomach was of the orthotonic or the ptotic type. A hypertonic type was never seen. These cases show the value of the direct bulbus examination by means of serial radiographs after the method of AKERLUND.

Discussion. VALKEN interrogates speaker about the value of an uneven border of the knee of the bulbus duodeni.

DE WILDE has never seen such cases.

VI. H. W. STENVERS: *Alterations of the Petrous Bone, Caused by Paget's Disease.*

PAGET'S disease is not always easily recognized clinically, and in one of speaker's cases (tumor in the accessory sinus) it was diagnosed in the plate by the merest chance. NOORDENBOS also described a malignant growth in a case of PAGET'S disease,

The alterations in cases of osteitis deformans, may differ very much as to localisation. Speaker will only discuss alterations of the skull. Examining a skeleton of a case of PAGET'S disease, he found the convex part much thickened, with coarse bone structure. The grooves for the meningeal arteries were unusually deep, the thickening being found especially on the outside. The base of the skull had lost much of its normal differences in depth. All sub-divisions were lying in about one plane. The foramen magnum had the shape of a key-hole and the borders of same as well as the surrounding parts were displaced in an upward direction.

The radiographs of these skulls show these alterations distinctly. At first sight, the typically spotted, coarse structure of the skull strikes us, in that the thickening does not extend over the occipital fossae. The sella turcica is very flat and rather broad and the base of the skull has lost its normal angle. The appearance of the patient is of great importance in re-

cognizing the disease. The patient does not always make the typical complaint of his hat having become too small; this symptom is absent especially with women. In those cases the general appearance of the patient can guide us in the diagnosis. MARIE has taught us how the face assumes an oval form, broader at the top, as contrasted with cases of acromegaly. The ears are now in a lower position, and are often protuding owing to the thickening of the skull, and this accounts also for the typical outward appearance of the patient.

In the bitemporal radiographs taken in vivo we see, in addition to the appearance described above, the vertebrae lying too deep in the skull, which gives us pictures similar to those seen in cases of impression of the base of the skull.

In frontal radiographs we observe, besides the sometimes immense thickenings of the skull, that the medial parts of the petrous bones are directed upwards, from which we may conclude that the lateral parts of the skull have sunk, the medial parts being supported by the atlas. This also explains the lower position of the ear.

The most prominent symptoms are those connected with the auditory organs, such as vertigo and singing in the ears. It has often been tried to explain these complaints on the hypothesis that the nerves suffer by obliteration of the different foramina, which causes injury to the nerves.

The fact that the deafness in cases of PAGET's disease is typical of middleear-deafness, renders this view but little probable. On comparing radiographs of petrous bones of normal skeletons with those of patients suffering from PAGET's disease, it strikes us that the normal bone shows a solid compacta round the semi-circular canals, whereas the diseased bone shows this compacta becoming spongy and partially disappearing.

Our patients with PAGET's disease show, whenever marked disturbances of the auditory and equilibrum organs are present, such great alterations in the petrous bones that even the whole structure of the petrous bones may have been obliterated.

Therefore speaker thinks that disturbances of the eight nerve in cases of PAGET's disease, may be the result of alterations in the structure of the petrous bone itself.

Discussion. NOORDENBOS draws attention to the fact that it has formerly been thought that the foramina of the skull in cases of PAGET's disease were not strictured, whereas in cases of leontiasis ossea they were. We now know, that PAGET's disease may also present symptoms caused by the narrowing of the foramina (neuralgia of the trigeminal nerve). He therefore thinks that the conclusion of STENVERS, i. e. that the alterations in the bone itself and not the strictures of the foramina cause the derangement in the action of the nerves, is not sufficiently proved.

STENVERS answers that neuralgia alone does not prove the existence of a stricture of a foramen. The trigeminus lies just at the point of the petrous bone; he thinks, that alterations in the bone are enough to account for neuralgia, even if unaccompanied by stricture of a foramen.

STEENHUIS thinks that alterations in the bone and stricture of foramina may together give rise to the complaints.

NOORDENBOS considers that the discussion has not proved that alterations of the bone alone, without a stricture, may cause the neuralgia.

INTERNATIONAL CONGRESS OF RADIOLOGY

Preliminary Meeting—London—1st to 4th July, 1925.

President of Congress: C. THURSTAN HOLLAND, D. L., Ch.M.
Chairman of Organising Committee: ROBERT KNOX, M.D.

The Organising Committee has pleasure in announcing that it has been decided to hold a Congress of Radiology in London in July 1925. The arrangements are being made jointly by the Electro-therapeutic Section of the Royal Society of Medicine, the Roentgen Society, and the British Institute of Radiology.

The Congress will be of an International character inasmuch as Radiologists from every country are invited to take part. Its objects are to bring together Radiologists from all parts of the world to discuss subjects of interest, and to secure the formation of a comprehensive International Committee and the establishment of a full International Congress to be held at stated intervals in different countries. It is hoped that at this London Congress arrangements will be made for the First International Congress, and that the date, and the country in which it will be held, will be decided upon by the International Committee. Physics, Electro-therapeutics and allied subjects will be included in the scope of the Congress.

Societies. Radiological and Electro-therapeutic Societies are invited to send approved representatives who shall be eligible to serve on the International Committee. Societies are requested to bring the Congress to the notice of their members and to secure the attendance of as many as possible.

Exhibitions. In connection with the Congress there will be an Exhibition of Radiological and Electrical apparatus. The exhibition will be open during the four days of the Congress, and there will be an official visit to the exhibition. Firms wishing to exhibit should apply for particulars. There will also be an Exhibition of Radiograms in which Dental Radiograms will be included.

Date. The opening Meeting of the Congress will take place on the morning of Wednesday, July 1st, 1925, and the other sessions will extend over that and the following days, ending on Saturday, July 4th. In the following week arrangements will be made for visits to other centres of interest.

On the evening of Tuesday, June 30th, a reception will be held so that Delegates and Members may have an opportunity of meeting before the opening of the Congress.

Papers. All papers intended to be read at the Congress must be sent to the Secretary General, at the British Institute of Radiology, not later than May 1st, accompanied by a short abstract. *It is particularly desirable that papers should, wherever possible, be approved by a recognised Society of which the author is a member.* All papers and abstracts must be typewritten or printed, and English translations will be much appreciated.

Authors will be notified of acceptance or otherwise of their papers as soon as possible after their receipt.

Each paper read at the Congress will be in the language selected by the author.

It is intended to publish Papers read at the Congress in the *British Journal of Radiology.*

Membership. It is hoped that all who wish to attend the Congress will signify their intention as soon as possible so that some estimate may be made of the numbers attending.

The fee for Membership of the Congress will be two guineas (£ 2 2 0).

Travel and Accommodation. Arrangements are being made through an agency for travelling facilities and hotel accommodation. Particulars will be sent on application to the Secretaries. Further particulars will be announced in due course, and the fullest possible information will be given to those applying. Correspondence and suggestions on any matter in connection with the Congress are cordially invited.

Address. The house of the British Institute of Radiology will be used as the administrative centre for the Congress. An information Bureau with interpreters will be provided.

All communication should be addressed to:—

The Secretaries, INTERNATIONAL CONGRESS OF RADIOLOGY,
c/o THE BRITISH INSTITUTE OF RADIOLOGY,
32 Welbeck Street, London, W.1.

DOKTOR SOFIE A. NORDHOFF-JUNG-KREBS-PREIS

Die Kommission für Verteilung des DOKTOR SOFIE A. NORDHOFF-JUNG-KREBS-PREISES hat in Übereinstimmung mit der Stifterin beschlossen, den Preis von jetzt ab nur alle 2 Jahre in der doppelten Höhe des bisherigen Betrages, also mit 1 000 Dollars, zu verteilen. Der nächste Preis wird 1926 zur Verteilung gelangen.

gez. Romberg.
Die Universität, München, Bayern.

NORDISK FÖRENINGS FÖR MEDICINSK RADIOLOGI

4:de möte

försiggår i Helsingfors den 1 och 2 september 1925

Inledningsföredrag:

1. **Röntgen- och Ljusbehandling vid kirurgisk tuberkulos.**
   Inledare för Danmark, CHIEVITZ: Den universelle Lysbehandling vid kirurgisk Tuberkulose, och
   REYN: Lyskilder til universel Lysbehandling.
   Finland, WETTERSTRAND: Röntgenterapin vid kirurgisk tuberkulos.
   Norge, HEYERDAHL: Lysbehandling ved chirurgisk tuberculose, och
   AMUNDSEN: Röntgenbehandling ved chirurgisk tuberculose.
   Sverige, EDLING: Röntgenbehandling vid kirurgisk tuberkulos,
   MALMSTRÖM: Bidrag till kännedomen om ljusterapien vid kirurgisk tuberkulos.
2. **Om undervisning i medicinsk radiologi.**
   Inledare: FORSSELL, HEYERDAHL.
   Diskussionsinlägg: PANNER.

Anmälan om föredrag böra göras senast den 15 maj till Dr G. A. WETTERSTRAND, *Helsingfors.* Finland.

Inledningsföredragen skola vara inlämnade i tryckfärdigt tillstånd till redaktionen av Acta radiologica senast d. 1 juni 1925.

Arbetsutskottet

NEWS ON THE BOOKSHELF
OF ACTA RADIOLOGICA

F. Blumenthal: Strahlenbehandlung bei Hautkrankheiten. S. Karger, Berlin 1925.

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Herman Wintz: Die Röntgenbehandlung des Uteruskarzinoms. Publ. Georg Thieme, Leipzig, 1924. Die Röntgenbehandlung des Mammarkarzinoms. Publ. do. H. Wintz & R. Dyroff: Das Pneumoperitoneum in der Gynäkologie Publ. do.

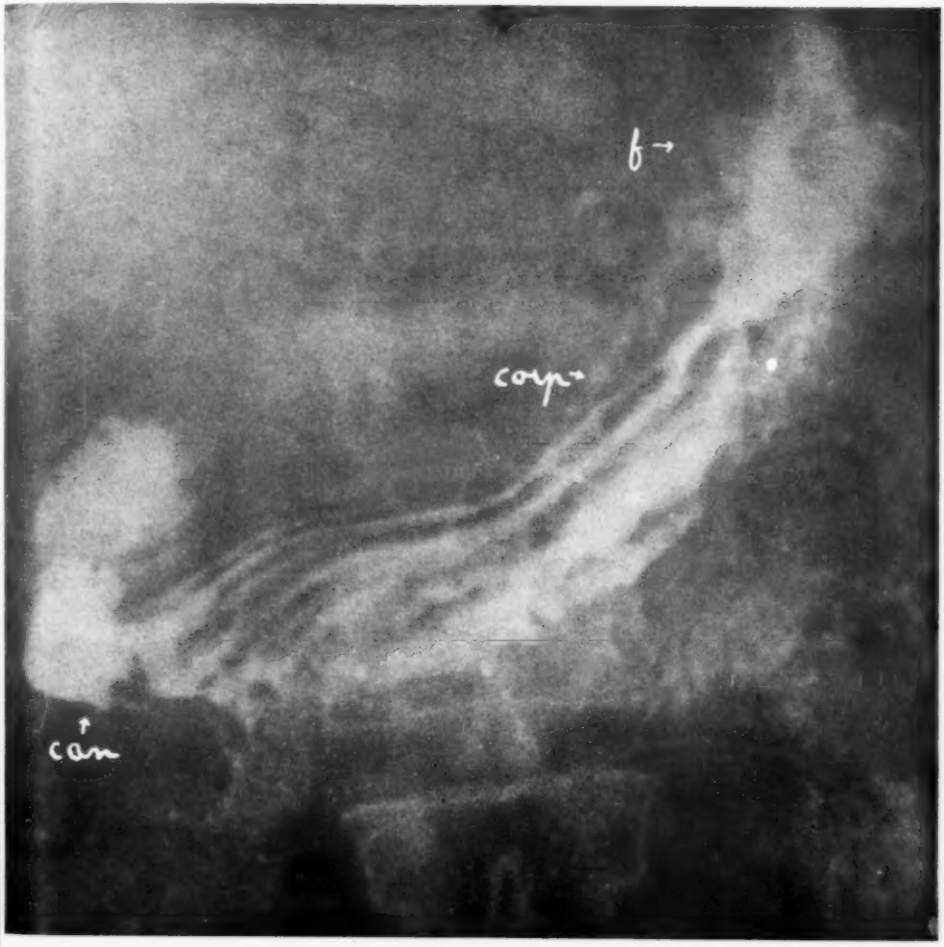

Fig. 1.

Fig. 2 b.

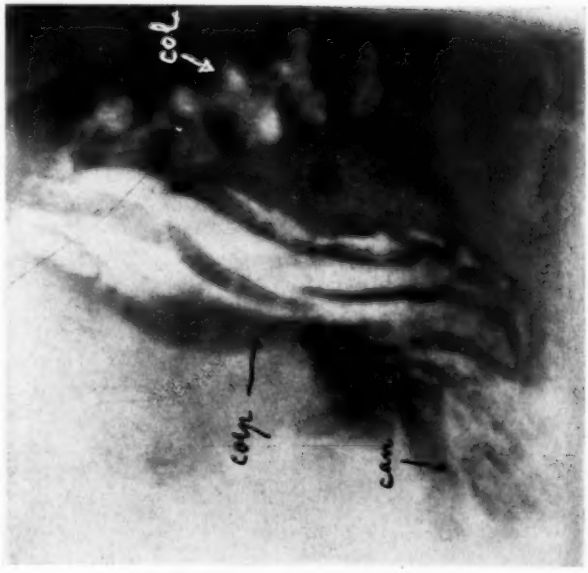

Fig. 2 a.

Fig 3.

Fig. 4.

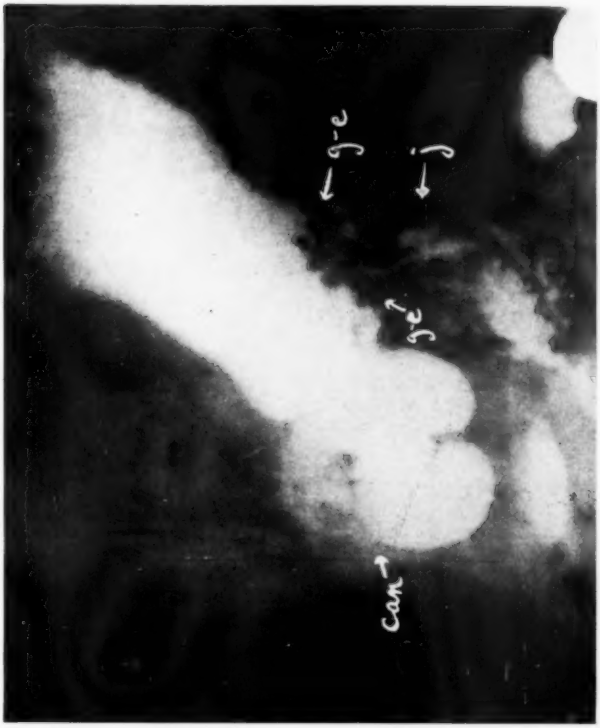

Fig. 5 b.

Fig. 5 a.

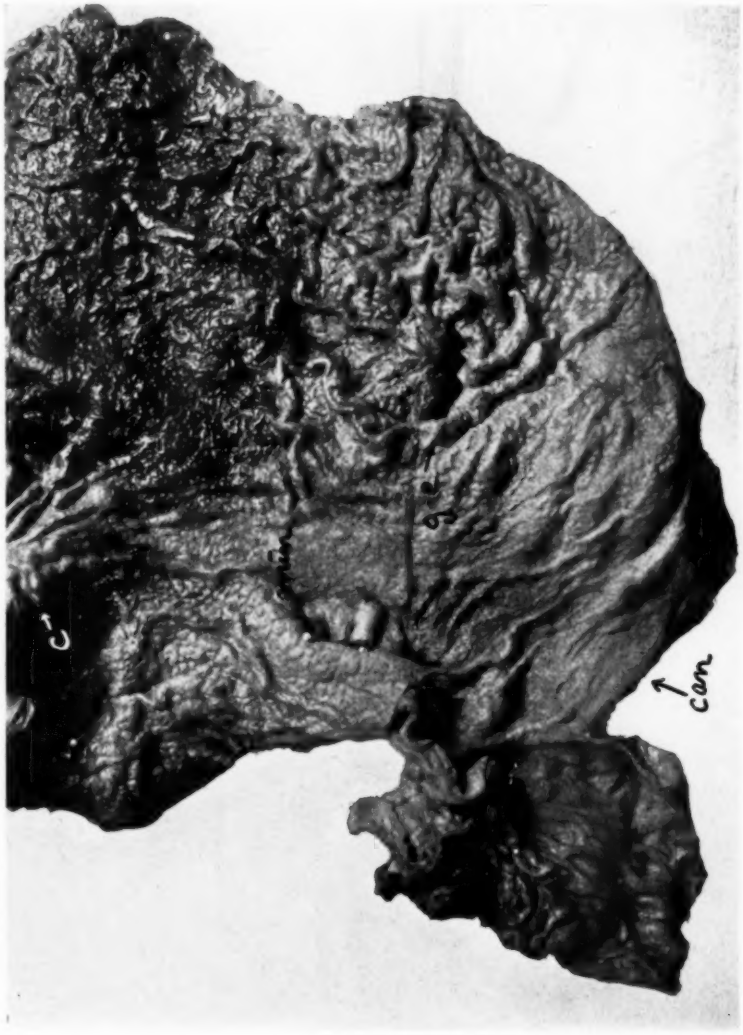

Fig. 6.

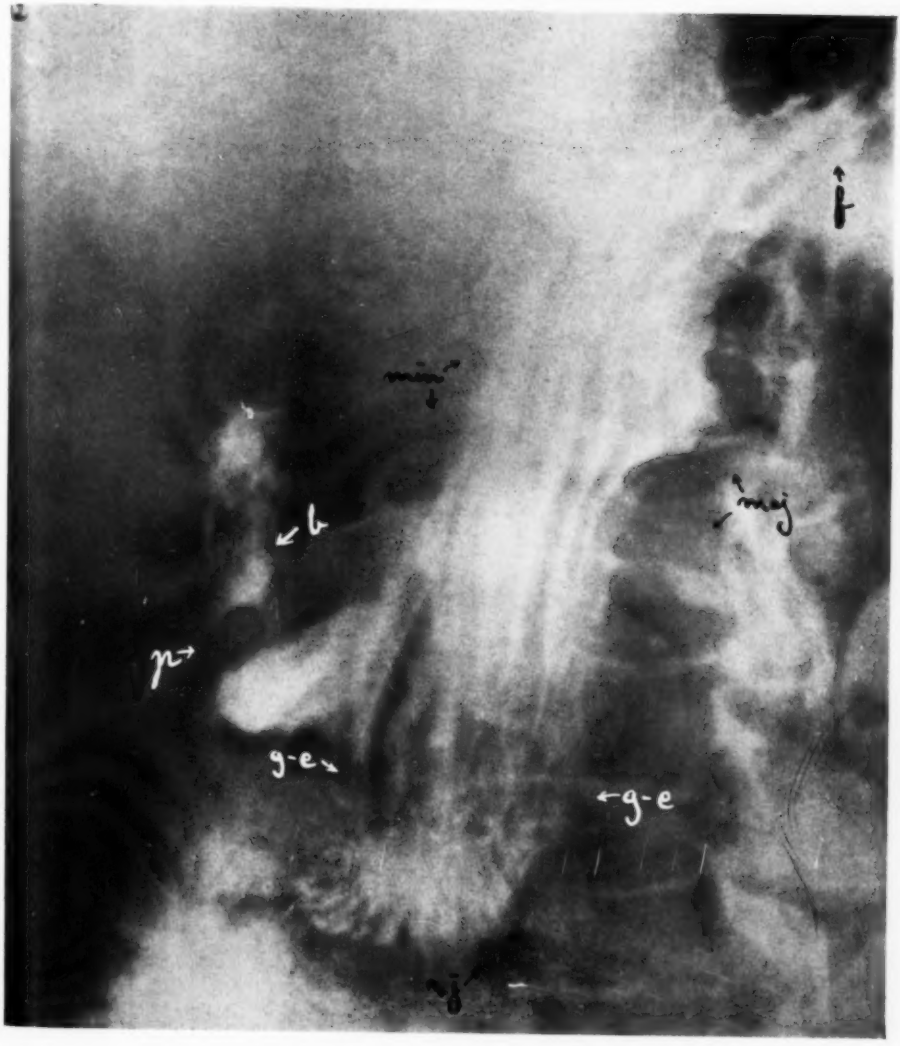

Fig. 7.

Fig. 8 b.

Fig. 8 a.

Fig. 9.

Fig. 10 b.

Fig. 10 a.

Fig. 11.

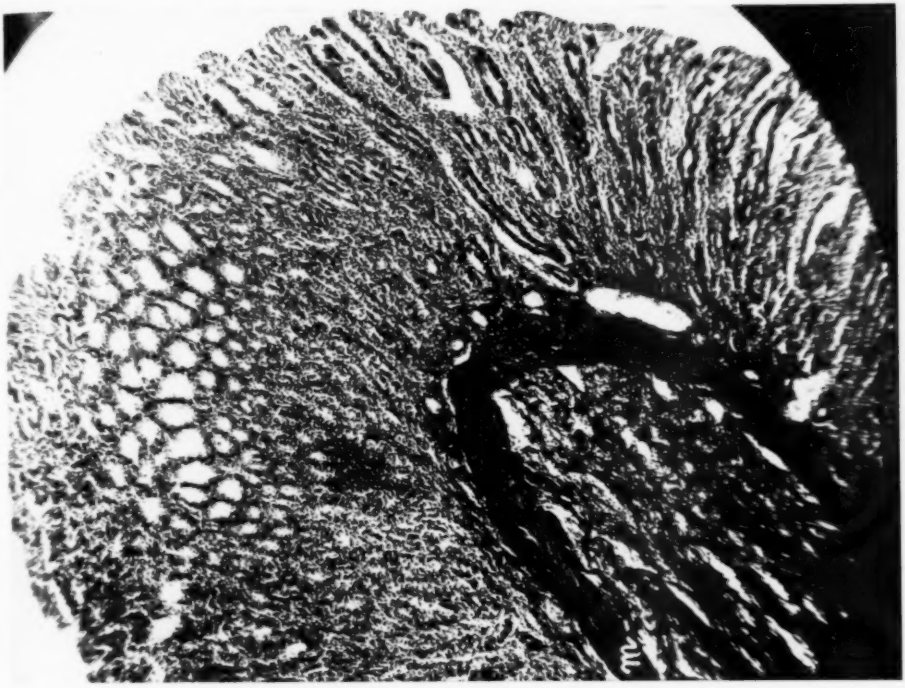

Fig. 12 b.

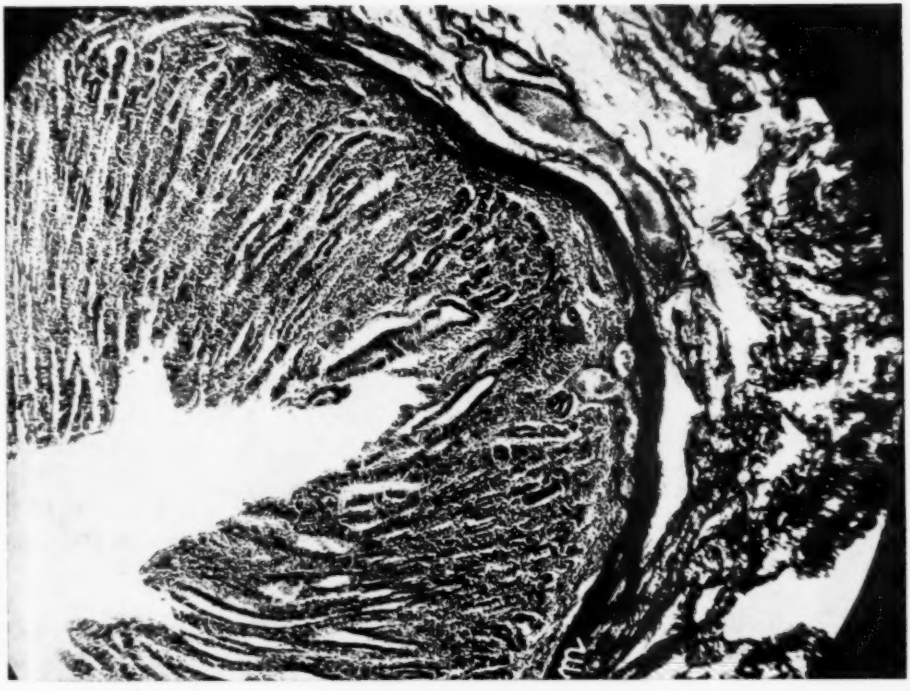

Fig. 12 a.

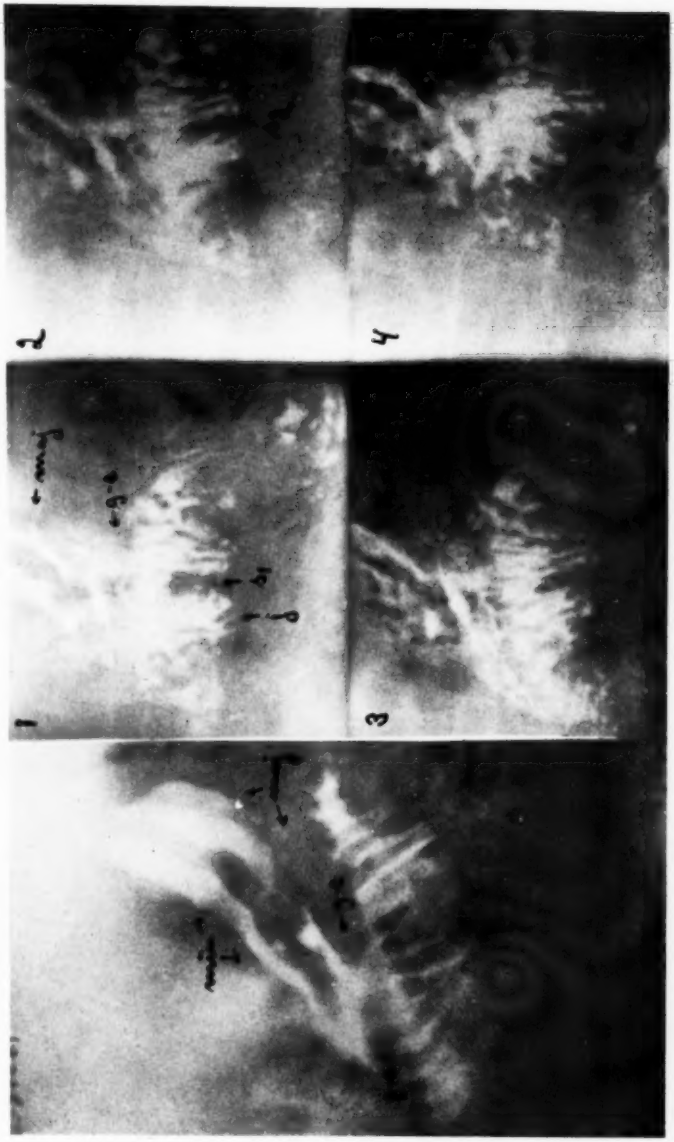

Fig. 13 b.

Fig. 13 a.

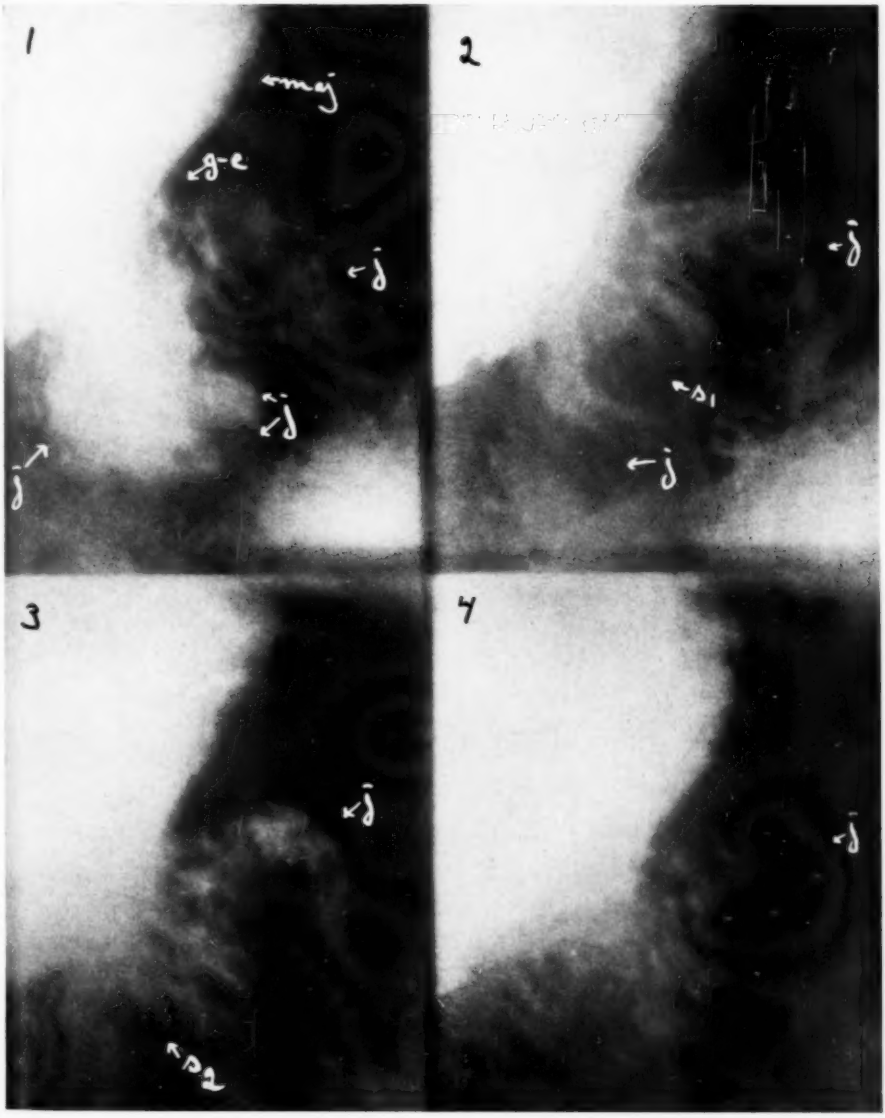

Fig. 14.

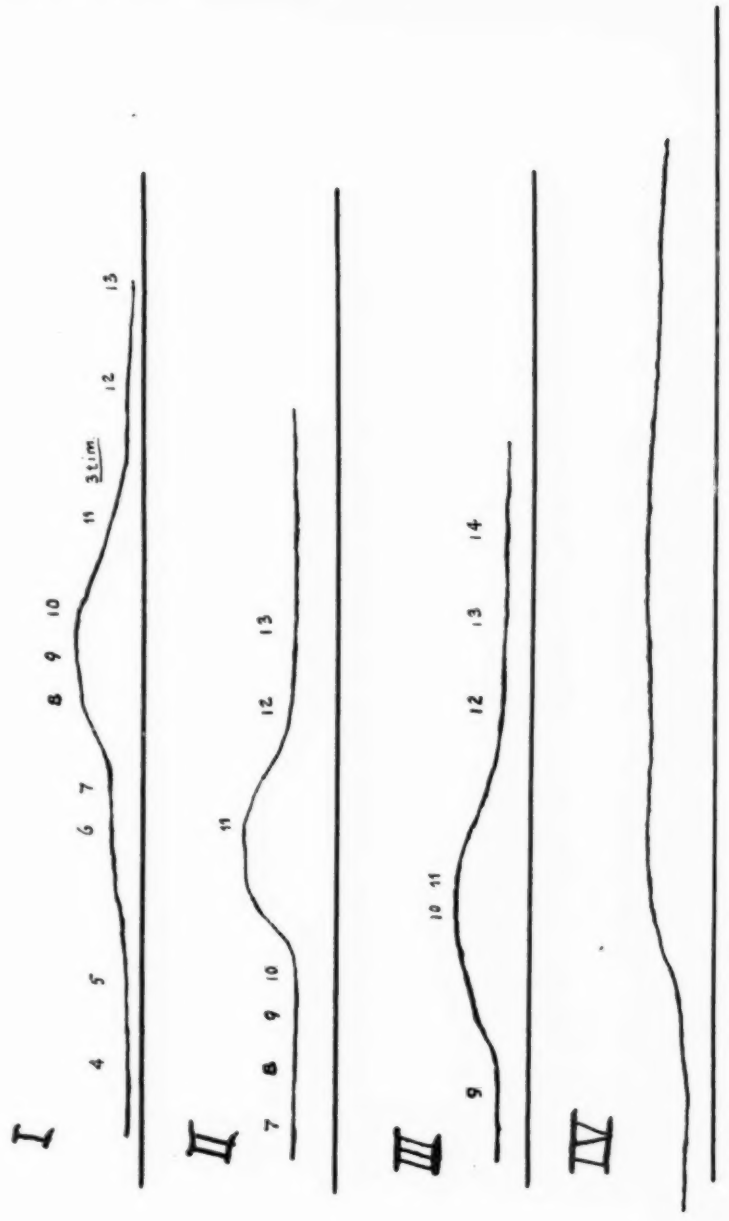

Fig. 15

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Tabula XIX

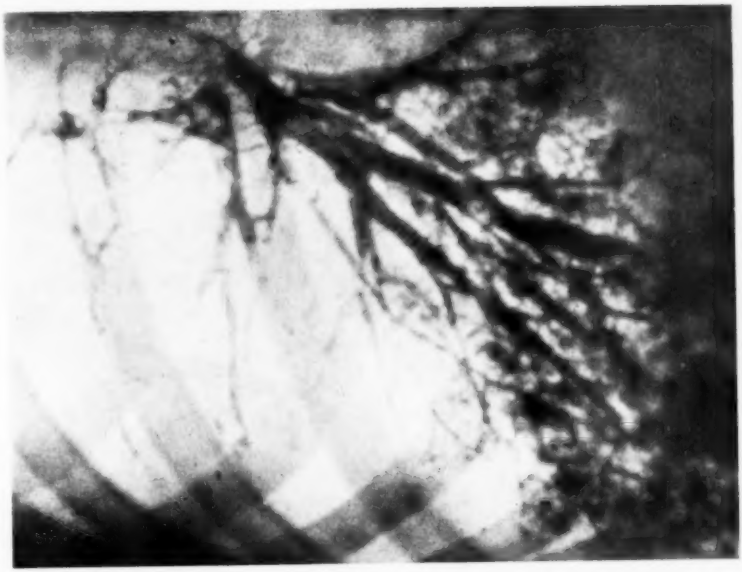

Fig. 1.

Fig. 2.

Fig. 3.